MANHATTAN:
THE ARMY AND THE ATOMIC BOMB

Maj. Gen. Leslie R. Groves, Officer in Charge, Manhattan Project

UNITED STATES ARMY IN WORLD WAR II

Special Studies

MANHATTAN:
THE ARMY AND THE ATOMIC BOMB

by
Vincent C. Jones

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. . . to Those Who Served

Foreword

The U.S. Army played a key role in the formation and administration of the Manhattan Project, the World War II organization which produced the atomic bombs that not only contributed decisively to ending the war with Japan but also opened the way to a new atomic age. This volume describes how the wartime Army, already faced with the enormous responsibility of mobilizing, training, and deploying vast forces to fight a formidable enemy on far-flung fronts in Europe and the Pacific, responded to the additional task of organizing and administering what was to become the single largest technological project of its kind undertaken up to that time.

To meet this challenge, the Army—drawing first upon the long-time experience and considerable resources of its Corps of Engineers—formed a new engineer organization, the Manhattan District, to take over from the Office of Scientific Research and Development administration of a program earlier established by American and refugee scientists to exploit the military potentialities of atomic energy. Eventually, however, the rapidly expanding project turned for support and services to a much broader spectrum of the Army, including the War Department, the Ordnance Department, the Signal, Medical, Military Police, and Women's Army Corps, the Military Intelligence Division of the War Department General Staff, and the Army Air Forces. These and other Army elements worked together in close collaboration with American industry and science to win what was believed to be a desperate race with Nazi Germany to be first in producing atomic weapons. For both soldiers and civilians this history of the Army's earlier experience in dealing successfully with the then novel problems of atomic science seems likely to offer some instructive parallels for finding appropriate answers to the problems faced in today's ever more technologically complex world.

Washington, D.C.
1 March 1984

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The Author

Vincent C. Jones, after graduating from Park College (Parkville, Missouri) with a B.A. in history, earned an M.A. degree at the University of Nebraska with a thesis on German public opinion in World War I and spent a year as a Sanders Fellow in History at George Washington University. Moving to the University of Wisconsin, he began work on a doctoral degree in modern European history just before the outbreak of World War II in Europe. During the war, he was a noncommissioned officer in a heavy weapons company of the 81st Infantry Division, participating in the Peleliu-Angaur and Leyte campaigns in the Pacific Theater. He was in training in the Philippines in August 1945, preparing for the impending invasion of Kyushu, when the Army Air Forces dropped atomic bombs on Hiroshima and Nagasaki. Following the surrender of Japan, he served in the American occupation forces in that country before returning to the University of Wisconsin as an instructor in history.

Completing his doctorate at Wisconsin in 1952, Dr. Jones served a year as a research associate in American history at the State Historical Society of Wisconsin and as an assistant professor of history at the Central State College of Connecticut. Since January 1955 he has been a historian on the staff of the U.S. Army Center of Military History, where he has been a major contributor to *The Army Almanac* and the ROTC textbook *American Military History*. In addition to the present volume, Dr. Jones is author of articles and reviews in professional journals and of biographical sketches of military figures in a number of encyclopedias.

Preface

During the nearly four decades since the atomic bombings of Hiroshima and Nagasaki in August 1945, much has been written about the developments leading up to that climactic moment in world history. Within days of that event, the War Department released its official account, the well-known semitechnical report by Professor Henry D. Smyth of Princeton University. Soon popular histories also appeared, and with the gradual opening of the archival records relating to the top secret World War II program known as the Manhattan Project, scholars began examining in detail the scientific, technological, strategic, and diplomatic story of atomic energy and the atomic bomb (see Bibliographical Note). Yet amid this outpouring of books, none has provided an adequate and full account of the United States Army's participation in the atomic program from 1939 to the end of 1946. It is the purpose of this volume to tell that story.

Stated in its simplest terms, the achievement of an atomic bomb resulted from the highly successful collaboration of American science and industry carried out under the direction and guidance of the U.S. Army. This triad—scientists, industrialists and engineers, and soldiers—was the product of a decision in early 1942 by America's wartime leaders to give to the Army the task of administering the atomic program. Convinced that the Allies were in a race with Germany to be the first to develop an atomic weapon, they decided that only the Army could provide the administration, liaison services, security, and military planning essential to the success of a program requiring ready access to scarce materials and manpower, maximum protection against espionage and sabotage, and, ultimately, combat utilization of its end product.

In telling how the Army met the challenge of its unique assignment, eventually achieving results that would have the most profound implications for the future of mankind, I have taken a broadly chronological approach but with topical treatment of detailed developments. The focus of the narrative is from the vantage point of the Manhattan Project organization, which functioned under the able direction of Maj. Gen. Leslie R. Groves and such key scientific administrators as Vannevar Bush, James B. Conant, Arthur Compton, and J. Robert Oppenheimer in compliance with policies established at the highest levels of the Washington wartime leadership. The volume begins with a prologue, designed to provide the reader with a brief survey of the history of atomic energy and to explain in layman's terms certain technical aspects of atomic science essential to an understanding of the major problems occurring in the development of an atomic weapon. Early chapters describe the beginning of the Army's atomic mission, including the formation of the Manhattan District, the first steps in acquiring the means to produce atomic weapons, and the appointment of General Groves. Subsequent topical chapters trace the building and operation of the large-scale process plants for the production of fissionable materials; the administration of a broad range of support activities, such as security and community management; and the fabrication, testing, and combat employment of atomic bombs. A concluding section describes how the Army dealt with the difficult problems arising during its unexpectedly prolonged postwar trusteeship of the project until December 1946, when the newly created civilian agency—the United States Atomic Energy Commission—assumed responsibility for atomic energy matters.

The Army did not program a volume on the Manhattan Project in its multivolumed historical series, the U.S. Army in World War II, until 1959. Two developments in the late 1950's had made available the essential records for research by Army historians: the instituting of a historical program by the Atomic Energy Commission, with the objective of preparing an unclassified account of its own origins; and the opening of access to the Manhattan District records, the so-called General Groves collection, then located in the Departmental Records Branch of the Adjutant General's Office but subsequently retired to the National Archives and Records System.

A great many individuals are deserving of mention for their assistance and support in the preparation of this volume. For aiding me in my task of researching the voluminous and widely scattered records controlled by the Department of Energy, I wish to thank Mr. Roger Anders, Dr. Richard G. Hewlett, and Mr. Thomas J. Pugliese in Germantown, Maryland; Mr. Floyd F. Beets, Jr., Mr. William J. Hatmaker, Mr. Frank Hoffman, and Mr. James R. Langley in Oak Ridge, Tennessee; Mr. Ralph V. Button and Mr. Milton R. Cydell in Richland, Washington; Mr. King Derr, Mr. David A. Heimbach, Mrs. Lucille McAndrew, and Mr. Robert Y. Porton in Los Alamos, New Mexico; Mrs. Eleanor Davisson in Berkeley, California; and Mr. E. Newman Pettit in Lemont, Illinois. For facilitating my use of the Manhattan Project records at the National Archives, I wish to thank Mr. Sherrod East, Dr. Lee Johnson, Dr. Herman Kahn, Mr. Wilbert B. Mahoney, Mr. Wilbur J. Nigh, Dr. Benjamin Zobrist, and, especially, Mr. Edward Reese, who on countless occasions rendered expert assistance in using the indispensable General Groves collection. And for making available interviews and photographs which they assembled for use in their own excellent account of the construction aspects of the Manhattan Project, I wish to thank Miss Lenore Fine and Dr. Jesse F. Remington, formerly of the Historical Division, Corp of Engineers.

Adding another dimension to my understanding of the atomic project were my visits to several Manhattan research, production, and community sites, arranged by Mr. Tom Cox and Mr. William McCluen at Oak Ridge, Mr. R. M. Plum and Mr. James W. Travis at Richland, Mr. Charles C. Campbell at Los Alamos, and Mr. P. M. Goodbread at Berkeley.

Many others gave generously of their time in reading and critiquing all or parts of the manuscript: Dr. James B. Conant, Col. William A. Consodine, Lt. Col. John A. Derry, Mr. Julian D. Ellett, Mr. Joseph R. Friedman, Dr. Crawford H. Greenewalt, Lt. Gen. Leslie R. Groves, Dr. Walter G. Hermes, Col. John E. Jessup, Jr., Dr. Richard G. Hewlett, Col. John Lansdale, Jr., Dr. Maurice Matloff, Col. Franklin T. Matthias, Maj. Gen. Kenneth D. Nichols, Mrs. Jean O'Leary, Mr. Robert R. Smith, Maj. Harry S. Traynor, and Col. Gerald R. Tyler. To each of them, I extend a special note of thanks.

At each stage in the preparation of this volume, I also benefited from the unique combination of talents available among my colleagues in the Army's historical office. Fellow staff historians—Dr. Stanley F. Falk, Dr. Maurice Matloff, and Dr. Earl F. Ziemke—helped expedite initial research into the atomic project records, serving with me as members of a team under the direction of Dr. Stetson Conn, the chief historian; in addition, Dr. Falk conducted a number of interviews and wrote the first draft of the Prologue, Chapters I–IV, and Chapter X. Miss Carol Anderson, in the library, and Miss Hannah Zeidlik, in the records branch, cheerfully and expertly dealt with my many requests and kept me abreast of newly available records and publications on atomic energy. Mr. Arthur S. Hardyman designed the graphically handsome maps, some of them in color, and oversaw the layout of the photographs. His colleague, Mr. Roger D. Clinton, provided the clearly drawn charts, which will help the reader understand the complex organization of the Manhattan Project, and assisted in the selection of photographs. The skillful typing of Mrs. Joyce Dean, Mrs. Margaret I. Fletcher, Mrs. Edna Salsbury, and Miss LaJuan R. Watson, the eagle-eyed proofreading of Mrs. Rae T. Panella, and the meticulous indexing of Mrs. Muriel Southwick contributed to the efficient preparation of my technically difficult and heavily documented manuscript. Lt. Col. John R. Pipkin shepherded the draft manuscript through clearance by several government agencies in record time, considering the potential sensitiveness of its subject matter. Finally, Miss Joanne M. Brignolo edited the volume. She demonstrated a remarkable capacity for quickly grasping the intricacies of atomic science, enabling her to make readable my oftentimes obscure text and to give order and consistency to its complex documentation. I am obliged to her for whatever literary merit my book may have.

For her understanding and unremitting support during the many years this volume was in preparation, I wish to thank my wife, Kay Cox Jones, who, as an employee at the Argonne National Laboratory in Chicago in the immediate post-World War II period, first brought my attention to the history of the atomic bomb.

For the many others not here mentioned who, over the years this volume has been in the making, have contributed in some way to its ultimate completion, I express my gratitude. The author alone, of course, takes responsibility for the facts presented and the conclusions reached in this volume.

Washington, D.C.
1 March 1984

VINCENT C. JONES

Contents

Page

PROLOGUE: A HISTORY OF ATOMIC ENERGY TO 1939 3
- *Uranium and Fission* 8
- *Efforts To Enlist Support of the U.S. Government* 12

Part One: Beginnings of the Atomic Mission

Chapter

I. THE ARMY AND THE ATOMIC ENERGY PROGRAM, 1939–1942 19
- *Origins of the Army's Role* 19
- *Decision To Develop Atomic Weapons* 21
- *Establishment of the NDRC and OSRD* 26
- *New Advances in Atomic Research, 1940–1941* 28
- *Top Policy Group: Preparing for Army Take Over* 30
- *Progress in Research and Development: The Nuclear Steeplechase* 35

II. ESTABLISHING THE MANHATTAN DISTRICT 40
- *Organizing the District* 41
- *Army-OSRD Planning Meeting, 25 June 1942* 46
- *Progress in Research and Development* 50

III. FIRST STEPS FOR WEAPON DEVELOPMENT 55
- *Securing an Architect-Engineer-Manager* 55
- *Obtaining Funds* 56
- *Securing a Priority Rating* 57
- *Procuring Essential Materials* 61
- *Site Selection* 67
- *Reaching Decisions: The Meeting at Bohemian Grove* 70

IV. GENERAL GROVES TAKES COMMAND 73
- *Reorganization and the Selection of Groves* 73
- *First Measures* 78
- *Establishment of Los Alamos* 82
- *Manhattan Project Organization and Operation* 88

Chapter Page

Part Two: Producing Fissionable Materials

V. ORGANIZING FOR PRODUCTION 95
- *Plutonium Project* 95
- *Reassessment of Processes To Produce a Bomb* 101
- *Contract Negotiations* 105
- *Hanford Engineer Works* 108
- *Plutonium Semiworks: Argonne vs. Tennessee* 111
- *Program Funding* 115

VI. THE ELECTROMAGNETIC PROCESS 117
- *Electromagnetic Research and the Army, 1942–1943* 118
- *Research and Development, 1943–1945: Radiation Laboratory* 120
- *Design and Engineering, 1943–1945* 126
- *Building the Electromagnetic Plant* 130
- *Plant Operation* 140

VII. THE GASEOUS DIFFUSION PROCESS 149
- *Gaseous Diffusion Research and the Army, 1942–1943* 149
- *Design and Engineering* 150
- *Building the Gaseous Diffusion Plant* 159
- *Plant Operation* 165

VIII. THE LIQUID THERMAL DIFFUSION PROCESS 172
- *Research and Development: The Role of the Navy* 172
- *Reassessment: Decision for Full-scale Development* 174
- *Plant Design, Engineering, and Construction* 178
- *Plant Operation* 180

IX. THE PILE PROCESS 184
- *Research and Development: Metallurgical Laboratory* 185
- *Organization for Plutonium Production* 198
- *The Semiworks: Clinton Laboratories* 204
- *The Hanford Production Plant* 210

Part Three: Support Activities

X. ANGLO-AMERICAN COLLABORATION 227
- *Breakdown of Interchange* 227
- *The Quebec Agreement* 232
- *Implementing the Agreement* 242
- *New Partnership Strains: Repatriation of French Scientists* 248

Chapter | Page

XI. SECURITY 253
Early Aspects 253
The District's Security System 254
Counterintelligence Activities 259
Safeguarding Military Information 268

XII. FOREIGN INTELLIGENCE OPERATIONS 280
Organization of the ALSOS Mission 280
ALSOS Operations in Italy 281
Manhattan's Special Intelligence Activities, 1944 282
ALSOS Operations in Western Europe, 1944–1945 285

XIII. THE RAW MATERIALS PROGRAM 292
Geographic Search and Field Exploration 292
Ore Control Agency: Combined Development Trust 295
Ore Acquisition in Foreign Areas 299

XIV. THE FEED MATERIALS PROGRAM 307
Program Organization and Support Activities 307
Feed Materials Procurement 310
Feed Materials Production 314
Quality Control Program 317

XV. LAND ACQUISITION 319
Clinton Engineer Works 319
Los Alamos 328
Hanford Engineer Works 331
Other Sites 342

XVI. MANPOWER PROCUREMENT 344
Personnel Organization 345
Scientific and Technical Personnel 348
Industrial Labor 350
Civilian and Military Personnel 355

XVII. MANPOWER CONSERVATION 363
Labor Turnover: The Problem and Its Cure 363
Special Problems With the Selective Service System 366
Labor Relations: Union Activities and Work Stoppages 369

XVIII. ELECTRIC POWER 377
Power Requirements and Sources 377
Implementation of the Power Program 386
Distribution: Clinton Engineer Works 388
Distribution: Hanford Engineer Works 391

Chapter *Page*

XIX. COMMUNICATIONS AND TRANSPORTATION 394
Communications 394
Transportation 397

XX. HEALTH AND SAFETY 410
The Health Program 411
The Safety Program 426

XXI. THE ATOMIC COMMUNITIES IN TENNESSEE 432
Oak Ridge: The Operating Community 432
The Construction Camps 440
Community Management 443

XXII. THE ATOMIC COMMUNITIES IN WASHINGTON STATE... 450
Selecting Sites 450
Hanford: The Construction Camp 452
Richland: The Operating Community 456
Community Management 460

XXIII. THE ATOMIC COMMUNITIES IN NEW MEXICO 465
Los Alamos: The Operating Community 465
Trinity: The Base Camp 478

Part Four: The Bomb

XXIV. THE LOS ALAMOS WEAPON PROGRAM 485
Planning Phase 485
Laboratory Administration 491
Post Administration 496

XXV. WEAPON DEVELOPMENT AND TESTING 503
Building the Bomb 503
Project Trinity: The Test of the Bomb 511

XXVI. THE ATOMIC BOMBING OF JAPAN 519
Preparations for an Atomic Bombing Mission 519
The Decision To Use the Bomb 530
Dropping the Bomb 534
The Surrender of Japan 541
Survey of the Bombing Effects 543

Chapter *Page*

Part Five: Completing the Atomic Mission

XXVII. THE ATOMIC AGE AND ITS PROBLEMS 553
The Atomic Story: Informing the Public 553
Atomic Energy: Planning for Postwar Control 562

XXVIII. THE ARMY AND THE ATOMIC ENERGY PROGRAM, 1945–1947 579
A Postwar Trusteeship 579
The Final Act: Transfer to Civilian Control 596

EPILOGUE: AN ATOMIC LEGACY 602
APPENDIX—EINSTEIN'S LETTER 609
BIBLIOGRAPHICAL NOTE 611
GUIDE TO ARCHIVAL COLLECTIONS 627
LIST OF ABBREVIATIONS 631
INDEX 643

Tables

No.
1. Stone and Webster Engineering and Design Personnel 127
2. Land Acquisition at CEW, 1942–1944 321
3. Comparative Estimates of Atomic Bombing Casualties in World War II 547

Charts

1. Organization of the Manhattan Project, April 1943 88
2. Organization of the Manhattan District, August 1943 90
3. Organization of the Manhattan District, January 1945 166
4. Feed Materials Network, January 1945 309
5. Estimated Officer Personnel Requirements for the Manhattan District, January 1943 356

Maps

1. Projected Site for Atomic Production Plants, Tennessee, 1942 48
2. Manhattan Project, 1942–1946 63
3. Clinton Engineer Works, Tennessee, 1943–1945 131
4. Hanford Engineer Works, Washington, 1943–1945 213

No. Page
5. Los Alamos Site, New Mexico, 1943–1945 330
6. Trinity Test Site, 1945 479
7. The Atomic Bombing of Japan, August 1945 525

Illustrations

Maj. Gen. Leslie R. Groves .... *Frontispiece*
Ernest O. Lawrence, Arthur H. Compton, Vannevar Bush, and James B. Conant 29
Secretary of War Henry L. Stimson 32
Brig. Gen. Wilhelm D. Styer 41
Brig. Gen. James C. Marshall 42
Col. Kenneth D. Nichols 43
Silver-wound Magnet Coils for the Electromagnetic Process 68
Approach Road to the Los Alamos Ranch School for Boys 85
Manhattan Project Emblem 89
Mrs. Jean O'Leary and General Groves 90
Col. E. H. Marsden 113
Excavation at the Tennessee Site 135
Alpha I Racetrack, Electromagnetic Plant, CEW 137
Electromagnetic Plant Under Construction 140
CEW Training Facilities 143
Electromagnetic Plant in Full Operation 147
Gaseous Diffusion Plant Under Construction, CEW 162
K–25 Steel-frame Construction 163
Completed Plant Section 168
Completed Gaseous Diffusion Plant 170
Richard C. Tolman 177
Liquid Thermal Diffusion Plant, CEW 181
Billboard at the S–50 Plant Site 182
University of Chicago Physics Building 186
Argonne Laboratory Near Chicago 187
124th Field Artillery Armory in Chicago 188
New Chemistry Building, Metallurgical Laboratory, Chicago 189
Heavy Water Plant at the Wabash River Ordnance Works 192
Maj. Arthur V. Peterson 195
Clinton Laboratories Pilot Pile, CEW 207
Clinton Laboratories 211
300 Area, HEW 215
100 B Pile Area, HEW 216
Chemical Separation Plant Under Construction, HEW 219
Completed Chemical Separation Plants 220
Sir James Chadwick, General Groves, and Richard Tolman 244

Page
Changing of the Guard, CEW 259
Security Sign at the Tennessee Site 269
Farm at the Tennessee Site 322
Typical Terrain of the Los Alamos Site 329
Military and Civilian Workers, CEW 355
Women's Army Corps Detachment, CEW 359
Enlisted Men at CEW During Off-Duty Hours 360
Large Troop Contingent at Los Alamos on Parade 361
Power Plant, HEW 379
K-25 Power Plant, CEW 384
Unimproved Santa Fe-Los Alamos Road 399
Improved Santa Fe-Los Alamos Road 400
Oak Ridge Bus Terminal 402
Gallaher Bridge Road at the Tennessee Site 405
Col. Stafford L. Warren 414
Hazardous Materials Storage Area, Los Alamos 421
Oak Ridge Hospital 423
Oak Ridge Shopping Mall and District Headquarters 437
Black Workers, CEW 438
Prefabricated Houses and Apartment Dwellings, CEW 440
Enlisted Men's Barracks, CEW 441
Gamble Valley Trailer Camp, CEW 442
Oak Ridge Elementary School 444
Main Post Office and Theater in Oak Ridge 445
CEW Reservation Entry Point 447
Chapel-on-the-Hill in Oak Ridge 448
Hanford Construction Camp, HEW 452
Camp Administrative and Residential Areas, HEW 453
Richland Village, HEW 456
Typical Building at the Los Alamos Ranch School 467
Family Apartment Units at Los Alamos 470
Military Mess Facility at Los Alamos 471
Los Alamos Ranch Trading Post 472
Street Scene in Los Alamos 473
Pupils at the Los Alamos Community School 474
Trinity Base Camp 480
J. Robert Oppenheimer 486
Lt. Col. Curtis A. Nelson 501
Technical Area at Los Alamos 505
Brig. Gen. Thomas A. Farrell and General Groves 512
Trinity Control Dugout and Observation Post 515
The Atomic Explosion at Trinity, 16 July 1945 516
Little Boy 522
Fat Man 523
Col. Elmer E. Kirkpatrick, Jr. 527
General Groves Checking Location of Bombing Targets 531

	Page
Col. Paul W. Tibbets, Jr., and Ground Crew at Tinian	535
Enola Gay at Tinian	537
Mushroom Cloud Over Hiroshima	539
Physical Damage at Hiroshima	546
Atomic Bombing Casualties at Nagasaki	548
Survivors of the Nagasaki Bombing	549
General Groves Holding a Press Conference	557
Henry D. Smyth and Richard Tolman	559
Oppenheimer Congratulating the Troops	582
Secretary of War Robert P. Patterson and General Groves	585
Transfer of Control to the Atomic Energy Commission	600

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MANHATTAN:
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PROLOGUE

A History of Atomic Energy to 1939

The concept of the atomic structure of matter first emerged in the fifth century B.C. with the Greek theory of minute particles, or atoms, as the unchangeable and indivisible units comprising all material things.[1] This new idea, however, lay dormant for nearly two thousand years because Aristotle's view that all matter is continuous and composed of four elements—fire, earth, air, and water—prevailed in the minds of men. Following the Renaissance in Europe such philosophers and scientists as Galileo, Descartes, Bacon, Boyle, and Newton supported the early concept, and in the nineteenth century chemists (somewhat later, physicists) transformed this atomic theory into a material reality.

One of the first and important steps was the theory proposed by English chemist John Dalton in 1803 that each element is composed of like atoms, distinguishable from the atoms forming other elements primarily by differences in mass. He thus provided a practical and specific standard for nineteenth century scientists' descriptions of ninety-two chemical elements (substances that cannot be broken down or transformed by chemical means). By the end of the century, all known elements had been arranged in a table, with similar properties in related positions, in numerical order according to atomic mass; it ranged from element 1, hydrogen, which was the lightest, to element 92, uranium, the heaviest. This "periodic table" not only enabled scientists to predict the properties of undiscovered elements but also became the basis of chemical and physical knowledge of the elements.

Beginning in the last decade of the nineteenth century, scientific discoveries by those European and American physicists who sought to explain the phenomenon of radioactivity opened the way for the modern development of atomic energy. This phenomenon is a property possessed by some elements to spontaneously emit radiation that ionizes gas and makes it capable of conducting electricity. Investigating electrical discharges in gases in 1895, German physicist Wilhelm Roentgen observed radiation emissions that penetrated opaque objects and also produced fluorescence. Roentgen's discovery of these radiations, which he called X-rays, led French physicist Henri Becquerel to test fluorescent salts of uranium to see if they also would produce penetrating rays. In 1896, Becquerel demonstrated that uranium emits penetrating radiations that would ionize gas, proof that it was radioactive.

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[1] A simple but excellent explanation of the atomic concept, including a good historical summary, is Selig Hecht, *Explaining the Atom*, 2d ed. (New York: Viking Press, 1954). The already classic, semitechni- al history is H. D. Smyth, *A General Account of the De- elopment of Methods of Using Atomic Energy for Military Purposes Under the Auspices of the United States Govern- ent, 1940–1945* (Washington, D.C.: Government rinting Office, 1945), hereafter cited as Smyth *eport*. See Bibliographical Note.

In England, physicist J. J. Thomson and a young student from New Zealand, Ernest Rutherford, used X-rays to ionize gases, providing further evidence that the penetrating rays were charged particles much smaller than atoms. In 1897, Thomson published data proving the existence of these particles, each having a mass of about one two-thousandth of a hydrogen atom. The following year he suggested that these particles, subsequently designated electrons, formed one of the basic building blocks comprising all atoms.

Rutherford's succeeding investigations showed that the penetrating streams of emitted particles are composed of at least three different kinds of rays—alpha, beta, and gamma. Alpha ray particles are heavy, high-speed, positively charged bodies, later shown to be nuclei of helium atoms; beta ray particles are electrons; and gamma rays are similar in composition to X-rays. In 1911, Rutherford proposed the theory of the nuclear atom, with its mass and positive charge at the center. The work of Rutherford, Niels Bohr, a Danish physicist, and others led to the concept of the atom as a miniature solar system, with a heavy positive nucleus orbited by much lighter electrons.

Rutherford finally achieved, in 1919, what man had been attempting unsuccessfully for centuries: the artificial transmutation of an element. Since the discovery of natural radiation, scientists had known that disintegration of radioactive elements in nature caused them to change spontaneously into other elements. Bombarding nonradioactive nitrogen with high-energy alpha particles given off by naturally radioactive radium, Rutherford caused the nitrogen to disintegrate and change into what subsequently proved to be a form of oxygen. His achievement, although somewhat removed from the ancient alchemist's dream of transmuting base metals into gold, was far more valuable and important. It was not only the first artificially induced transmutation; it was also the first controlled artificial disintegration of an atomic nucleus.

A further Rutherford achievement was isolation and identification of yet another basic building block of atomic structure. In addition to oxygen, nitrogen transmutation had produced a high-energy particle with characteristics similar to the positively charged nucleus of the hydrogen atom. Later study showed it was a hydrogen nucleus, and scientists gave it the name proton. Such a positively charged particle as a fundamental unit in the structure of all atoms had long been hypothesized; demonstration of its presence in nitrogen and other elements confirmed its identity.

Discovery of the proton pointed toward the existence of a third particle. In 1932, James Chadwick, Rutherford's co-worker at Cambridge University, discovered this third particle, the neutron, an uncharged body approximately equal in weight to the proton.

Now the atom was viewed as composed of a positively charged nucleus, containing protons and neutrons, orbited by negative electrons equal in number to the protons. The number of protons determined the atomic number, or numerical position, of the parent element in the periodic table. Thus hydrogen, element 1, has but a single proton; helium, element 2, two protons; and uranium, element 92, ninety-two protons. For each proton there is a balancing electron. The mass, or atomic weight, of an element is the sum of its protons and neutrons; the electrons, with negligible weight, do not materially affect the mass of the atom. The weight of each element is stated in relation to that of hydrogen, the lightest. Hydrogen, with a single proton and no neutrons, has an atomic weight of 1; helium, with 2 protons and 2 neutrons of equal weight, a mass of 4; and uranium, with 92 protons and 146 neutrons, a mass of 238. The chemical symbols for these elements are written ${}_1H^1$, ${}_2He^4$ and ${}_{92}U^{238}$.

Thus far, three characteristics of elements had been identified: chemical uniqueness, atomic number, and atomic weight. But scientists also discovered that many elements exist in more than one form, differing solely in the number of neutrons that each contains. For example, there are two forms of helium, each with two protons and two electrons. They are chemically identical but one form has a single neutron, thus an atomic mass of 3, and the other, more prevalent form two neutrons, thus an atomic mass of 4. These substances are called isotopes (from the Greek words *iso,* meaning alike or same, and *topos,* meaning place) because they occupy the same place in the periodic table. The chemical symbols for the helium isotopes are written ${}_2He^3$ and ${}_2He^4$, or simply He–3 and He–4; or they may be spelled out, helium 3 and helium 4. Many other isotopes exist, either naturally or through scientific transmutations, and they are important in the story of atomic energy.

James Chadwick's discovery of the neutron was not the only significant development in 1932. That same year British scientist J. D. Cockcroft and Irish scientist E. T. S. Walton, working together at Cambridge University's Cavendish Laboratory, used a particle accelerator to bombard lithium with a stream of protons, causing the element to disintegrate. Unlike Rutherford, who experimented with alpha particles from natural sources, Cockcroft and Walton, in effect, produced their own protons through artificial means.

This artificially induced nuclear disintegration, however, was only one aspect of Cockcroft and Walton's accomplishment. As a hydrogen nucleus, or proton, struck a lithium nucleus, the latter body disintegrated into two alpha particles of helium nuclei. The hydrogen atom with a mass of 1 united with a lithium nucleus having a mass of 7, thereby making a total mass of 8, and then this body immediately divided into two helium nuclei, each with a mass of 4. Thus, the two scientists were also the first to bring about atomic fission—or, in the popular phrase, to split the atom.[2]

Still another result of the Cockcroft-Walton experiment, and at the time considered most important, was its confirmation of Einstein's theory of relativity, proposed in 1905, that matter and energy are merely different forms of the same thing. The atomic weights of the lithium, hydrogen, and helium nuclei expressed by Cockcroft and Walton in their experiment were only approximate. The combined mass of a lithium nucleus and a hydrogen nucleus is, in fact, very slightly more than the combined mass of two helium nuclei. Thus, the formation of two helium nuclei had resulted in a loss of mass. This lost mass was converted into energy in an amount that could be calculated by the Einstein equivalence formula $E=mc^2$ (energy is equal to mass multiplied by the square of the velocity of light) or derived from the speed of the helium nuclei as they flew apart from the lithium. Because the two calculations provided answers in very close agreement, they confirmed Einstein's theoretical projection and opened the prospect of using atomic fission as a major new source of energy.

In the experiments conducted so far, however, the total energy required to bombard the atomic nucleus and produce fission was much greater than the energy released. This initially high input of energy enabled the charged particle to approach and penetrate the atom, overcoming the repulsion of their mutual electrical charges. Furthermore, even when high-speed particles were used, only one in a million succeeded in hitting its target. This inefficiency led Rutherford to describe using nuclear fission as an energy source as practical as "moonshine," [3] and so it indeed appeared to many.

But Chadwick's discovery of the neutron provided the solution. The neutron, because it was an uncharged particle, would not be repelled and therefore could penetrate a nucleus even at relatively slow speeds. Proof was to come from Italy, where in 1934 Enrico Fermi and his co-workers set about systematically bombarding the atoms of all known elements with neutrons. They soon demonstrated that the nuclei of several dozen elements could be penetrated by neutrons and thereby broken down and transmuted into nuclei of other elements. Their best results were obtained when the bombarding neutrons were first slowed down by passing them through such moderators as carbon or hydrogen.

The most important result of Fermi's work was not fully understood for another four years. Among the substances he had bombarded with slow neutrons was uranium, which was naturally radioactive and the heaviest of all known elements. Theory and chemical analysis seemed to indicate that the substance produced by uranium transmutation was nothing hitherto known, but was in fact a new and heavier element. Uranium is element 92; this new element appeared to be element 93, or possibly even element 94. Fermi, so it seemed, had created transuranic elements not present in nature, and the popular press hailed his achievement as a major advance in science.[4]

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[2] Sir John Cockcroft, "The Development and Future of Nuclear Energy," *Bulletin of the Atomic Scientists* 6 (Nov 50): 326.

[3] Ibid.

Yet many scientists were skeptical, and Fermi himself was uncertain. The properties exhibited by the new substances were not those they had expected to find in transuranic elements. For the next four years, physicists and chemists were hard at work attempting to identify exactly what Fermi had produced. Progress was slow, exacerbated by the uncertainty of the times; fearing the advancing wave of political oppression, many scientists in Germany, Austria, and Italy fled to havens elsewhere in Europe and in the United States. Nevertheless, out of Nazi Germany, the answer finally came. Just before Christmas of 1938, the radiochemists Otto Hahn and Fritz Strassmann concluded that one of the products of Fermi's experiment was not a transuranic element at all. It was, rather, the element barium, with an atomic weight approximately half that of uranium.[5]

When Hahn informed his former co-worker, Lise Meitner, of the conclusions that he and Strassmann had reached, the Austrian physicist—who had recently escaped from Germany to Sweden—quickly comprehended the significance of the findings. Working with her nephew, British (Austrian-born) physicist Otto Frisch, she concluded that the bombardment of uranium by slow neutrons produced two elements of roughly half the weight of uranium. In the splitting process there was a tremendous release of energy, far more than necessary to cause fission. Without delay she passed this exciting information on to Niels Bohr, who was about to leave Denmark for an extended stay at the Institute for Advanced Study at Princeton University. Thus, even as Hahn and Strassmann published the results of their work in Europe, Bohr carried news of their conclusions to the United States.[6]

Further experiments confirmed the discovery of atomic fission and raised the possibility that a practical means of obtaining atomic energy could at last be realized. Splitting the uranium atom released not only energy but also two or three additional neutrons. Perhaps, under the right conditions, these neutrons might smash other atoms, releasing more neutrons to bombard more atoms while simultaneously generating a continuous emission of energy. This process, or chain reaction, would be self-sustaining and would continue for as long as uranium atoms were present to be split.

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[4] Laura Fermi, *Atoms in the Family: My Life With Enrico Fermi* (Chicago: University of Chicago Press, 1954), Ch. 6 and passim; Enrico Fermi, *United States, 1939–1954,* The Collected Papers of Enrico Fermi, ed. Emilio Segre et al., Vol. 2 (Chicago: University of Chicago Press, 1965).

[5] See Charles Weiner, 'A New Site for the Seminar: The Refugees and American Physics in the Thirties," in *The Intellectual Migration: Europe and America, 1930–1960,* Perspectives in American History, Vol. 2 (Cambridge, Mass.: Charles Warren Center for Studies in American History, Harvard University, 1968), pp. 190–234; Norman Bentwich, *The Rescue and Achievement of Displaced Scholars and Scientists, 1933–1952* (The Hague: Martinus Nijhoff, 1953).

[6] Lise Meitner, "Looking Back," *Bulletin of the Atomic Scientists* 20 (Nov 64): 2–7; S. Rozental, ed., *Niels Bohr: His Life and Work as Seen by Friends and Colleagues* (Amsterdam: North-Holland Publishing Co., 1967).

During 1939, scientists in America, England, France, Germany, the Soviet Union, Japan, and other countries worked intensively to extend both the theoretical and experimental knowledge of atomic fission. By the end of the year, nearly one hundred papers on the subject had been published.[7] In the United States, native Americans and a group of European refugees combined their energies and scientific talents to investigate various aspects of the complex problem, carrying on their work at such institutions as Columbia, Johns Hopkins, Princeton, the University of California at Berkeley, and the Carnegie Institution in Washington, D.C.[8]

Uranium and Fission

Uranium is considered a rare element, although it is a thousand times more prevalent than gold. Uranium is more widely dispersed and occurs infrequently in a relatively concentrated form. Found always with radium, primarily as uranium oxide, it occurs mainly in pitchblende and in carnotite ores. Before World War II the main value of these ores lay in their radium content, although uranium was also used for coloring glassware and ceramics, for tinting photographic film, and for making certain steel alloys. Uranium was rarely produced as a metal; metallurgists had not yet measured its melting point accurately.

Substantial radium-uranium concentrations in the Shinkolobwe mine in Katanga Province of the Belgian Congo were owned by the Union Miniere du Haut Katanga, a Belgian firm that completely dominated the world market. So rich were the Shinkolobwe concentrations that in 1937 the company, having stockpiled sufficient ore to satisfy the anticipated world demand for radium and uranium for the next thirty years, ceased mining operations.

Important but less productive deposits were located in the Eldorado mine at Great Bear Lake in northern Canada, and ores of much lower grade were found in the Colorado Plateau region in the western United States; however, Colorado Plateau radium and uranium producers were forced to close down because they could not compete commercially with those in the Congo and Canada. In addition, other uranium deposits of varying quality were located in Czechoslovakia, Portugal, England, Madagascar, and elsewhere.[9]

Natural uranium is composed of three isotopes: U-238, about 99.28 percent; U-235, about 0.71 percent;

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[7] Summarized in Louis A. Turner, "Nuclear Physics," *Reviews of Modern Physics* 12 (Jan 40): 1-29.

[8] Among the many scientists at work in the United States on fission research were Herbert L. Anderson, John R. Dunning, Enrico Fermi, George B. Pegram, Leo Szilard, and Walter Zinn at Columbia; Edwin M. McMillan at the University of California, Berkeley; Edward Teller at George Washington University; and John A. Wheeler and Eugene Wigner at Princeton. In France were Frederic Joliot-Curie, Hans von Halban, and Lew Kowarski; in England, George P. Thomson, James Chadwick, Rudolph Peierls, and others; and in Germany, Otto Hahn, Fritz Strassmann, and Werner Heisenberg. The Soviet Union, too, had a number of able and active physicists in fission research. See Arnold Kramish, *Atomic Energy in the Soviet Union* (Stanford: Stanford University Press, 1959), Chs. 1-3.

[9] "The Distribution of Uranium in Nature," *Bulletin of the Atomic Scientists* 1 (Feb 46): 6; Ms, Office of the Historian, Armed Forces Special Weapons Project, "Manhattan District History" (hereafter cited as MDH), ed. Gavin Hadden, 8 bks., 36 vols. (Dec 48), Bk. 7, Vol. 1, "Feed Materials and Special Procurement," pp. 1.1-1.7, 2.1-2.2, 3.1-3.2, 4.1-4.2, DASA.

and U-234, just a trace. Experimenting with the isotopic properties of uranium, scientists eventually proved that U-235 was fissionable by both slow and fast neutrons, although more controllably so by the former.

When U-235 fissions, it emits fast neutrons, which are captured by the U-238. The U-238 does not fission but becomes radioactive and disintegrates. For a chain reaction to be self-sustaining, at least one neutron emitted by the U-235 has to penetrate another U-235 atom. Because the fast neutrons are most easily absorbed by the U-238, the 140-to-1 ratio of U-238 to U-235 in natural uranium makes it even more improbable that the neutrons can escape the U-238 and be captured by U-235 atoms. Many neutrons, moreover, escape altogether from the uranium and others are absorbed by impurities within it. This is why uranium does not fission in its natural state and why an emission of neutrons does not occur in any ordinary lump of uranium.

Proper conditions for achieving a chain reaction required that the number of neutrons absorbed by impurities in uranium and the number of neutrons lost through its surface or captured by its U-238 isotope be kept to a minimum. Neutron absorption could be decreased by using a careful chemical process to remove the impurities, although the technique was difficult and posed major problems. Because the number of neutrons lost from a piece of uranium depends on the area of the surface and because the number of neutrons captured depends on its mass or volume, neutron escape or capture could be reduced by using a suitable shape and size. The greater the amount of uranium, the smaller would be its surface area relative to volume and thus, proportionately, the fewer neutrons that could be lost through the surface or captured by the U-238. During fission, production of at least one neutron in excess of those lost or captured would cause the uranium to reach its critical mass and possibly trigger a chain reaction.

The dilemma researchers faced in 1939 was ascertaining the exact size of this critical mass. The consensus was that a tremendous amount of uranium—far more than had ever been produced and concentrated—would be necessary. A practical solution to the supposed enormity of the problem therefore was to reduce the size of the critical mass by decreasing the number of neutrons captured by the U-238. The U-235 could be separated from the U-238, or the ratio of U-235 to U-238 could be increased artificially.

Theories about what should be done, however, did not quite coincide with what could be done at this stage of the research. Because the two uranium isotopes were chemically identical, their separation by chemical means was impossible. And the about 1-percent difference in mass between U-235 and U-238 meant that separation by physical means would be most difficult. Although producing a sufficient amount of pure U-235 or U-235-enriched natural uranium to maintain a chain reaction in a critical mass of practical proportions appeared only barely possible, there were those who continued to work on the multistage problem of separating what were considered, in Fermi's words, "almost magically inseparable" isotopes.[10]

All separation methods deemed possible were based on the difference in atomic weight. One process, the electromagnetic method, employed a mass spectrometer or spectrograph. In this process a stream of charged particles of a given element is projected through a magnetic field, which deflects them from their original path. Because the atoms of a heavier isotope will be more strongly affected by the magnetic field than those of a lighter isotope, the stream of particles will be separated into two or more streams, each containing a different isotope, which can then be collected in different receivers. Alfred O. Nier of the University of Minnesota did the initial work on this process. At this time, the electromagnetic method proved to be not only ridiculously slow but also quantitatively insufficient. It would have taken twenty-seven thousand years for each mass spectrometer to produce a single gram of U-235 or 27 million spectrometers a whole year to separate a kilogram of the isotope.

Another process, the gaseous diffusion method, was based on the principle that if two gases of different atomic weights are passed through a porous barrier, the lighter gas will diffuse through more readily. First, uranium would have to be transformed from its naturally solid state into a gas; then, because of the 140-to-1 ratio of U-238 to U-235, the diffusion process would have to be repeated in order to produce any appreciable amount of U-235 or U-235-enriched uranium. Scientists in Great Britain performed most of the early theoretical and experimental work on this method. In the United States, it was not until late 1940 that physicist John R. Dunning and a small group of collaborators at Columbia University began intensive research into the technical problems of gaseous diffusion.[11]

A third method was the centrifuge process, in which uranium in a gaseous form is rotated rapidly in a cylinder. Because centrifugal force causes the atoms of the heavier isotope to amass along the outer walls and those of the lighter isotope to concentrate around the axis of rotation, the desired isotope can then be drawn off. Jesse W. Beams at the University of Virginia and others in the United States seemed to offer the best initial promise for separating uranium isotopes, but the magnitude of the engineering problem was such that, as with the other separation methods, the centrifuge process offered no quick or easy solution.

The avenues of research were not solely limited to isotope separation methods. At Columbia University, Enrico Fermi and Leo Szilard, a refugee physicist from Hungary, experimented with the possibility of achieving a chain reaction in uranium without separating its isotopes—research that in the not too distant future would culminate in the world's first chain reaction. Basing their investigations on research that Fermi had carried out five years earlier on the use of moderators to slow down neutrons, they explored the likelihood that a moderating substance might be mixed with natural uranium in such a way that the high-speed fission-produced neutrons could be sufficiently slowed before meeting other uranium atoms so as to escape capture by U–238 and remain free to penetrate the U–235.

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[10] Enrico Fermi, "Physics at Columbia University: The Genesis of the Nuclear Energy Program," *Physics Today* 8 (Nov 55): 14.

[11] For Dunning's work see MDH, Bk. 2, Vol. 2, "Research," pp. 3.1–3.2, DASA.

The two most promising moderators were hydrogen and carbon. Water might make a good moderator; however, because hydrogen exists in two natural isotopes (light hydrogen, the more prevalent, with a mass of 1, and heavy hydrogen, or deuterium with a mass of 2), "heavy water," containing deuterium, should make an even better one. Scientists in France and England had investigated the use of heavy water, but it was extremely costly to produce and was highly volatile. Feeling that heavy hydrogen was in some ways less efficient as a moderator, Fermi and Szilard turned their attention to carbon, which was readily available in the form of graphite. Proving its feasibility through theoretical investigation and experimentation would take time, energy, and money, but the two scientists were confident they could achieve a chain reaction.[12]

Because such a chain reaction could provide a tremendous amount of energy in a form that might be converted into power, this uranium-graphite system promised to have ready military application for driving large ships or aircraft but seemed impractical for use as a bomb. A bomb would have to be so large that the sudden release of energy in an uncontrolled nuclear explosion would blow it apart before more than a small amount of energy was freed; that amount was not worth the great effort necessary to detonate it.

Yet, if it were possible to separate U–235 from the naturally more prevalent U–238 or to enrich natural uranium greatly in its U–235 isotope, then a fast-neutron chain reaction might be achieved and extremely powerful bombs, far smaller than any explosive uranium-graphite system, could probably be built. Controlled energy from a fast-neutron chain reaction could, of course, be used as a power source; but, uncontrolled, it would provide a far more powerful explosion than ever before attained by man. Though perhaps too heavy for a conventional bomber, a U–235 bomb could be brought by ship into an enemy port and exploded with devastating effect.

In early 1939, however, the chances of constructing a bomb of U–235 appeared far less certain than those of building a power-producing uranium-graphite system. To use Fermi's words, there seemed "little likelihood of an atomic bomb, little proof that we were not pursuing a chimera." [13]

Nevertheless, possible military application of atomic energy was of increasing interest to a group of foreign-born physicists now living and working in the United States. These men—including Enrico Fermi from Italy; Leo Szilard, Eugene Wigner, and Edward Teller from Hungary;

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[12] For the activities of Fermi and Szilard during 1939 see Enrico Fermi, "Physics at Columbia," pp. 12–16; Ms, Leo Szilard, "Documents Relating to Period March 1939 to July 1940" (hereafter cited as Szilard Documents), Incl to Ltr, Compton to Groves, 13 Nov 42, Admin Files, Gen Corresp, 201 (Szilard), MDR.

[13] Laura Fermi, *Atoms in the Family*, p. 164.

and Victor Weisskopf from Austria—knew that government-supported nuclear research was under way at the Kaiser Wilhelm Institute in Berlin, and the likely military consequences of a German breakthrough worried them very much. As most of them had only recently fled their homelands to escape fascist tyranny, they had no wish to see Nazi Germany acquire a means of dominating the whole world. Indeed, if any nations were to exploit atomic energy for military purposes, they believed the democracies would do well to be first.

These physicists therefore directed their energies toward two ends: keeping all advances in nuclear research a secret to discourage an all-out German effort, and obtaining support from the American government for further nuclear research. The group almost achieved one of its goals in early 1939, when leading physicists in the United States and Great Britain pledged not to publish the results of their work in the field. However, in France, Frederic Joliot-Curie refused, and his determination to publish his own research led to continued publication by scientists in other countries. It was not until late 1940, after a large number of articles had appeared in scientific journals and the popular press, that publication on atomic energy generally ceased.

Efforts To Enlist Support of the U.S. Government

The atomic scientists' first attempt to gain support from the U.S. government for their atomic energy research came in March of 1939, even as German troops were completing the occupation of Czechoslovakia. Scheduled to give a lecture in Washington, D.C., on the sixteenth, Enrico Fermi arrived in the national capital with a letter of introduction from Dean George B. Pegram of Columbia to Rear Adm. Stanford C. Hooper, director of the Technical Division, Office of the Chief of Naval Operations. On the morning of the seventeenth, Fermi met with Admiral Hooper and other individuals, including Ross Gunn, a physicist and techical adviser of the Naval Research Laboratory. Pegram, who was also a physicist, had explained in his letter what Fermi discussed in his lecture, namely, the importance of atomic energy and its possible uses for mankind, although both men were prudent about making predictions.

Gunn and his associates at the Naval Research Laboratory already were aware of the potentialities of atomic energy; however, they were more interested in the prospects for nuclear ship propulsion than in developing an atomic bomb. Now Fermi's visit spurred them on to continue their own investigations, but it did not lead to any naval support for the scientists working at the universities.[14] A second approach to Gunn, made by Szilard in June, was no more successful. While the Navy pursued its own program of research on uranium isotope separation, Gunn indicated to Szilard in July that "it seems almost impossible, in the light of the restrictions which are imposed on Government contracts for services, to carry through any sort of agreement that would be really helpful to you."[15]

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[14] Ibid., pp. 162–65; Testimony of Gunn in U.S. Congress, Senate, Special Committee on Atomic Energy, *Atomic Energy: Hearings on S. Res. 179*, 79th Cong., 1st and 2d Sess., 27 Nov 45–15 Feb 46 (Washington, D.C.: Government Printing Office, 1945–46), pp. 365–67. Gunn testified that Army officers were present at the 17 March conference, but this does not appear to have been the case.

By mid-July, then, Szilard, Teller, and Wigner concluded that another channel had to be found. The results of ongoing nuclear research indicated that a chain reaction could very probably be achieved in a uranium-graphite system, "and that this possibility had to be considered as an imminent danger."[16] There was, moreover, ominous news from Europe of continued German interest and progress in nuclear research. American scientists returning from visits to Germany reported a growing emphasis on the investigation of isotope separation, with the apparent objective of achieving a fast-neutron chain reaction in U–235, the basis of an atomic bomb.[17] After moving into Czechoslovakia, the Germans closed the door on the country's uranium ore exports. Convinced that the need to keep other uranium deposits from falling into German hands required action at the highest level, Szilard, Teller, and Wigner approached Einstein. At first, Szilard thought to have Einstein approach the Department of State and use his acquaintance with the royal family in Belgium as a means for stopping uranium ore shipments to the Germans. But, after further discussion, he decided a direct approach to the White House was necessary. Through a refugee journalist friend, Szilard secured an introduction to Alexander Sachs, a Wall Street economist and student of international affairs who had long been an informal adviser of President Franklin D. Roosevelt. Sachs was familiar with the subject of atomic energy, having read avidly Hahn and Strassmann's first report and having followed subsequent publications on atomic fission. Also, he had become acutely aware of the possible military applications of atomic energy during Niels Bohr's visit to the Institute of Advanced Study at Princeton. Indeed, the growing tensions in Europe and Germany's increasing threat to world peace eventually led him to discuss the Hahn-Strassmann report and its possible effect on the international situation in a brief session with Roosevelt early in March.

Sachs agreed to help, and he and Szilard concluded that a letter from Einstein to Roosevelt would emphasize the importance of their message. The letter, primarily the work of Szilard, was drafted in Sachs's office. Szilard and Teller took it to Einstein, who was vacationing on Long Island, on 2 August. Sources disagree over whether Einstein rewrote the Sachs-Szilard draft or merely put his name to it; but, in any event, Szilard returned to Sachs with a signed letter from Einstein to the President.[18]

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[15] Ltr, Gunn to Szilard, 10 Jul 39, Szilard Documents, MDR.

[16] Szilard Documents, p. 7, MDR.

[17] Arthur Holly Compton, *Atomic Quest: A Personal Narrative* (New York: Oxford University Press, 956), p. 118.

[18] Account of approach to President Roosevelt through Sachs based on Interv, Stanley L. Falk with Sachs, 18 Jul 60, CMH; Ms, Alexander Sachs, "Early History [of] Atomic Project in Relation to President Roosevelt, 1939–40" (hereafter cited as Sachs History), 8–9 Aug 45, pp. 1–6, Admin Files, Gen Corresp, 201 (Sachs), MDR; Testimony of Sachs in *Atomic Energy Hearings on S. Res. 179*, pp. 2–11 and 553–59; Szilard Documents, p. 7, MDR; Otto Nathan and Heinz Norden, eds., *Einstein on Peace* (New York: Simon and Schuster, 1960), pp. 291–97; Nat S. Finney, "How F.D.R. Planned To Use the A-Bomb,"

Continued

This letter, a milestone in the American atomic energy program, states that "it is almost certain that this [a chain reaction in a large mass of uranium] could be achieved in the immediate future" and that this phenomenon could possibly lead to the construction of a new type of an extremely powerful bomb.[19]

To this letter, Szilard himself added a careful memorandum. In it he explained in more detail the scope and effects of research on atomic fission, the unproved nature of its conclusion, and the need for financial support for further investigation. He pointed out that atomic energy released through a chain reaction achieved with slow neutrons could be utilized for ship or aircraft propulsion, and also raised the possibility that a fast-neutron chain reaction would result in a powerful explosive. Szilard also reemphasized the need for acquiring large stocks of uranium ore from the Belgian Congo and suggested that another attempt to arrange for the withholding of publications on the subject of nuclear research might be necessary.[20] Included with the letter and memorandum were reprints of two articles from the *Physical Review* that provided documentation of the scientific points raised by Einstein and Szilard.

Despite the agreed upon necessity for haste, almost two months passed before Sachs was able to bring Einstein's letter and its inclosures to the White House. "Mere delivery of memoranda was insufficient," he felt.[21] In the hectic days of August and September 1939, with war in Europe first an imminent danger and then a frightening actuality, there seemed little likelihood that Roosevelt could spare Sachs more than a few moments. Not until early October did Sachs find a time he felt was suitable to approach the President.

The story of Sachs's visit to the White House has been told frequently and with several variations. Suffice it to say that Sachs met with Roosevelt for over an hour on 11 October. Reading aloud, Sachs prefaced Einstein's letter and Szilard's memorandum with a letter of his own in which he summarized and amplified the other material, emphasizing German nuclear research, the danger of German seizure of Belgian uranium, and the "urgent" need to arrange for American access to the uranium ore of the Belgian Congo. He stressed the necessity of enlarging and accelerating experimental work, which could not be done on limited university budgets, and seconded the suggestion made in Einstein's letter for liaison between the government and the scientists.[22]

The President's initial reaction was one of skeptical interest. He was doubtful about the availability of funds to support nuclear research and

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Look, 14 Mar 50, pp. 25–27; Geoffrey T. Hellman, "A Reporter at Large: Contemporaneous Memoranda of Dr. Sachs," *New Yorker*, 1 Dec 45, pp. 73–76; Edward Shils, "Leo Szilard—A Memoir," *Encounter* 23 (Dec 64): 35–41; Eugene Rabinowitch, "1882–1964" and "1898–1964" (obituaries on James Franck and Leo Szilard, respectively), *Bulletin of the Atomic Scientists* 20 (Oct 64): 16–20.

[19] Ltr, Einstein to Roosevelt, 2 Aug 39, reproduced in the Appendix to this volume.

[20] Memo, Szilard to Roosevelt, 15 Aug 39, Szilard Documents, MDR.

[21] Testimony of Sachs in *Atomic Energy Hearings on S. Res. 179*, p. 556.

[22] Ltr, Sachs to Roosevelt, 11 Oct 39, Exhibit 3, Sachs History, MDR.

felt, moreover, that there were other aspects of national defense with a higher claim for attention. Nevertheless, he invited Sachs to breakfast the next morning and, at this second meeting, was convinced of the necessity for action.

President Roosevelt's 12 October decision to explore the potentialities of atomic energy eventually led to complete governmental direction of nuclear research in the United States. And, in the early years of its development, no single government agency was to play a more important role than the United States Army.

PART ONE

BEGINNINGS OF THE ATOMIC MISSION

Chapter I

The Army and the Atomic Energy Program, 1939–1942

At eight o'clock on the evening of 17 June 1942, Col. James C. Marshall received a teletype message from Washington, D.C., to report to Maj. Gen. Eugene Reybold, chief of the Corps of Engineers, "for temporary duty,"[1] thus interrupting his present assignment as commanding officer of the Syracuse (New York) District. Arriving at General Reybold's office the next day, Marshall received further instructions to report to Brig. Gen. Wilhelm D. Styer, chief of staff to the commanding general of the War Department's Services of Supply, a major division newly created to oversee Army logistics. Late in the afternoon, Colonel Marshall learned from General Styer the precise nature of his new assignment: General Reybold had chosen him to form a new engineer district "for construction of a new manufacturing plant."[2] The location had not been selected but, Styer explained, the plant would be part of a project already in progress to develop atomic energy for military purposes. Thus the Army became directly involved in a project in which it had been playing a minor and somewhat intermittent role since the fall of 1939.

Origins of the Army's Role

The Army's expanded role in the American atomic energy program in mid-1942 grew out of developments that had occurred as a result of the outbreak of World War II and the subsequent involvement of the United States in that conflict. On the morning of 12 October 1939, persuaded by Alexander Sachs's urgent arguments, President Roosevelt agreed to investigate the desirability of providing some preliminary support for independent and private research. Roosevelt's military aide, Maj. Gen. Edwin M. Watson, immediately requested that the Army and the Navy send officers to the White House to talk to an "inventor" about a new explosive. At two o'clock that same afternoon, the Army sent Lt. Col.

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[1] Col James C. Marshall, Chronology of District X (hereafter cited as Marshall Diary), 17 Jun 42–31 Oct 42, OCG Files, Gen Corresp, Groves Files, Misc Recs Sec, behind Fldr 5, MDR. On Marshall's earlier career see George W. Cullum, *Biographical Register of the Officers and Graduates of the U.S. Military Academy*, 9 vols. (1–3, 3d rev. ed. and enl., Boston: Houghton, Mifflin and Co., 1891; 4–9, aegis of Association of Graduates, U.S. Military Academy, 1901–50), 6B:1978, 7:1298, 8:366, 9:258.

[2] Marshall Diary, 18 Jun 42, MDR.

Keith F. Adamson, chief of the Ammunition Division, Ordnance Department, and his chief civilian assistant, Arthur Adelman; the Navy sent Comdr. Gilbert C. Hoover, also an ordnance specialist. In General Watson's office, Sachs repeated much of his earlier presentation to the President. After some discussion, the group broke up with the understanding that Watson would advise them what specific action the President desired.[3]

The Army's Chemical Warfare Service (CWS) also received Sachs's material on atomic energy. Lt. Col. Haig Shekerjian, the CWS executive officer, and another chemical warfare officer may have been present at the meeting in the White House, or they may have been briefed later in the afternoon. General Watson's objective was to test Sachs's information against the knowledge and experience of the technical services most likely to be concerned with development of nuclear research and bombs. Ironically, the technical service that eventually had the most to do with development of the atomic bomb, the Corps of Engineers, was not consulted.[4]

The first reaction of the Army representatives to the military potentialities of atomic energy was not generally enthusiastic. Colonel Adamson displayed a cool skepticism, although he later warmed to the subject. He apparently questioned whether nuclear research had advanced far enough for the government to support it with any reasonable hope of success. Moreover, with an eye to Sachs's Wall Street background, he was suspicious of the financier's motives in urging purchase of Belgian Congo uranium.[5]

A similar response came from the Chemical Warfare Service. Despite Colonel Shekerjian's favorable reaction, Maj. Maurice E. Barker, chief of the CWS Technical Division, expressed a decidedly negative view. After studying Einstein's letter and Szilard's memorandum, Major Barker concluded that there was "no basis" for believing that the bombardment of uranium by neutrons would produce an explosion. While conceding that the proposed nuclear research "would be extremely interesting, and might have considerable scientific value," he thought that "the chance of anything of military value being developed . . . so slight that it would not justify the expenditure of funds available for research for that purpose." [6]

The Army's initial skepticism may be attributed to a number of factors. For all of Alexander Sachs's enthusiasm, even the group of American and foreign-born physicists still regarded the potentialities of atomic energy as only a "reasonable possibility," [7] as the tentative tone of Einstein's letter and Szilard's memorandum readily showed. Unlike the Navy, in 1939 the Army had no central research organization that might have seized upon the abstract possibilities of atomic energy. Consequently, budget-minded Army officers, who had served through a period of extremely restricted military expenditures in the 1930's, were not likely to lose their restraint over new and possibly far-fetched ideas. They had witnessed drastic cuts in funds, especially for Army research and development, which was allotted only 1.1 percent of military expenditures in fiscal year 1939. Army policy called for immediate development of critical items rather than eventual production of better weapons and equipment through prolonged research. Ordnance and chemical officers were, of course, particularly aware of this situation. Thus, it was hardly surprising hat Sachs's proposals failed to trans- ate their scientific conservatism into nilitary enthusiasm.[8] Not until civil- an research and development had uttressed the theoretical predictions f the physicists with undisputable cientific evidence and the nation was nvolved in war would the Army ssume a principal role in developing e military potentialities of atomic nergy.

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[3] Intervs, Stanley L. Falk with Adamson, 22 Apr 60, and with Sachs, 18 Jul 60; Ltr, Adamson to Maj Gen Levin H. Campbell, Jr. (Chief of Ord), 26 Jun 44; Memo, Arthur Adelman, sub: Fission Explosives (hereafter cited as Adelman Fission Memo), 30 Jun 44, p. 4. All in CMH.

[4] Adamson and Sachs Intervs, 22 Apr 60 and 18 Jul 60; Interv, Falk with Shekerjian, 27 Oct 59; Ltr, Adamson to Campbell, 26 Jun 44; Adelman Fission Memo, pp. 4–5; Ltr, Shekerjian to Falk, 11 Sep 59. All in CMH.

[5] Adamson and Sachs Intervs, 22 Apr 60 and 18 Jul 60, CMH; Ltr, Adamson to Campbell, 26 Jun 44, CMH; *Washington Post*, 26 Mar 46.

[6] Quotation from Memo for File, Barker, sub: Uranium Activated by Neutrons as an Explosive and Source of Power (Proj A 10), 13 Oct 49, Incl G to Adelman Fission Memo. Shekerjian Interv, 27 Oct 59. Ltr, Shekerjian to Falk, 11 Sep 59. All in CMH.

[7] Louis A. Turner, "Nuclear Physics," *Reviews of Modern Physics* 12 (Jan 40): 21.

Decision To Develop Atomic Weapons

Through the President's Advisory Committee on Uranium, established on 12 October 1939, the Army had an opportunity to express its generally negative reaction to the military potentialities of atomic energy. This small group, charged with making recommedations on the ideas and materials submitted by Sachs, was comprised of Colonel Adamson, Commander Hoover, and, as chairman, Lyman J. Briggs. Briggs was director of the National Bureau of Standards, which was one of the principal government agencies of the pre-World War II period concerned with research in the physical sciences.[9]

The first meeting of the Uranium Committee, as it came to be called, took place on the morning of 21 October at the Bureau of Standards.The committee had invited Alexander Sachs and, at his suggestion, also Leo Szilard, Edward Teller, Eugene Wigner, and Albert Einstein to attend its session. Einstein was unable to be present but two other physicists, Fred L. Mohler of the Bureau of Standards and Richard B. Roberts of the Carnegie Institution, attended to provide the committee with technical guidance. Szilard, Teller, and Wigner outlined the steps they believed necessary to attain a chain reaction in the uranium-graphite system proposed by Fermi and Szilard. During their presentation, the three scientists requested $6,000 to purchase the graphite and emphasized the need for secrecy about all activities relating to nuclear research.

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[8] Mark S. Watson, *Chief of Staff: Prewar Plans and parations* (Washington, D.C.: Government Print- Office, 1950), pp. 31-32 and 42-44; Constance Laughlin Green, Harry C. Thomson, and Peter Roots, *The Ordnance Department: Planning Munitions War* (Washington, D.C.: Government Printing ce, 1955), pp. 204-08; Leo Brophy and George . Fisher, *The Chemical Warfare Service: Organizing War* (Washington, D.C.: Government Printing ce, 1959), pp. 37-38. All in the series U.S. Army orld War II.

[9] Smyth *Report*, p. 32; Ltr, Sachs to Wigner, 17 Oct 39, Exhibit 4, Sachs History, MDR; Ltr, Roosevelt to Einstein, 19 Oct 39, President's Secy's Files, Sachs Fldr, FDR; Sachs Interv, 18 Jul 60, CMH; Rexmond C. Cochrane, *Measures for Progress: A History of the National Bureau of Standards* (Washington, D.C.: National Bureau of Standards, U.S. Department of Commerce, 1966), p. 362.

In the discussion that followed, three schools of thought became apparent. Colonel Adamson and Commander Hoover, generally skeptical, stated their belief that several years of further research would be needed even to determine whether the military possibilities of atomic energy were sufficient to justify government support. In contrast, Sachs, Briggs, and Teller were almost enthusiastic about the chances of success. Maintaining a more conservative approach, Szilard and Wigner portrayed the great possibilities of their work but also stressed the as yet tentative nature of their conclusions.[10]

In spite of the cautious attitude of Adamson and Hoover, the Uranium Committee's report to the White House on 1 November gave the scientists in effect what they wanted. While conceding that the harnessing of atomic energy for power or bombs was still only a theoretical possibility, the committee nevertheless recommended that "in view of the fundamental importance" and "potential military value" of nuclear research, "adequate support for a thorough investigation of the subject should be provided." This support should include funds for immediate purchase of 4 metric tons of pure graphite and, if the results of initial experiments warranted continuing the program, additional funds to obtain 50 tons of uranium oxide.[11]

The Uranium Committee submitted its report and recommendations to President Roosevelt through General Watson. Apparently viewing the report as preliminary, Watson asked Chairman Briggs for a special recommendation before he advised the President. Until then, no executive action could be expected.

Consequently, the members of the Uranium Committee kept in touch with the nuclear research program at Columbia University, awaiting word of progress from the scientists. In the interim, the Naval Research Laboratory continued its interest in university research that pertained to its own investigations into isotopic separation. At this stage, however, neither the Navy nor the Uranium Committee made any effort to coordinate or link the various nuclear research programs in progress. Such attempts as were made came from the scientific community and from Sachs rather than from any governmental agency.[12]

Then, in January 1940, Briggs took the first concrete step to obtain government funds for the university scientists. From the Navy, up to now more interested in nuclear research than the Army, Briggs obtained a promise of $3,000. On 15 January, he called on Maj. Gen. Charles M. Wesson, the chief of Army Ordnance, and asked him to match this sum. Briggs outlined the potentialities of atomic fission. "It appears," reads the account of the conversation in General Wesson's office diary, "that this development has possibilities from an explosive viewpoint." These "possibilities" and Briggs's reference to the fact that the President was "interested in this project" were enough to make the Ordnance chief agree to advance $3,000 out of Picatinny Arsenal funds for the development of explosives.[13]

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[10] Sachs History, pp. 6–7, Admin Files, Gen Corresp, 201 (Sachs), MDR; Adamson and Sachs Intervs, 22 Apr 60 and 18 Jul 60, CMH; *Washington Post*, 26 Mar 46; Memo, Szilard, sub: Mtg of 21 Oct 39 in Washington, D.C., 26 Oct 39, Incl H to Adelman Fission Memo, CMH; Szilard Documents, p. 7, Admin Files, Gen Corresp, 201 (Szilard), MDR.

[11] Quoted words from Memo, Briggs, Adamson, and Hoover to President, sub: Possible Use of Uranium for Submarine Power and High Destructive Bombs, 1 Nov 39, Exhibit 5, Sachs History, MDR (also in Adelman Fission Memo, following p. 5, CMH). Testimony of Sachs in *Atomic Energy Hearings on S. Res. 179*, p. 560.

[12] Sachs History, pp. 10–11, MDR; Ltr, Adamson to Campbell, 26 Jun 44, CMH; Adamson Interv, 22 Apr 60, CMH; Testimony of Gunn in *Atomic Energy Hearings on S. Res 179*, p. 367.

The Army and Navy funds went to the Bureau of Standards, which allotted them to Columbia University in mid-February. Fermi and his colleagues used the money to purchase graphite in quantities that, at the time, seemed huge. They needed a sufficient amount of the highly purified carbon substance to determine its capture cross section, that is, its capacity to absorb neutrons. With this information they could then ascertain the practicability of achieving a slow-neutron chain reaction in a uranium-graphite system.[14]

Meanwhile, Alexander Sachs and the scientists exerted increasing pressure on the President and the Army and Navy. Einstein wrote to Sachs on 7 March, summarizing the situation and suggesting that the information concerning new evidence of German interest in atomic energy be passed on to President Roosevelt. This Sachs did, including also Einstein's recommendations that steps be taken to halt publication of articles on atomic subjects and that a "general policy . . . [be] adopted by the Administration with respect to uranium." But Einstein's views brought no immediate response from the White House. In fact, after discussion with Colonel Adamson and Commander Hoover in late March, General Watson accepted Adamson's suggestion that no further action be taken until an official report on the research at Columbia was available.[15]

The official report was not ready, however, when the Uranium Committee held its second meeting on 27 April 1940. The meeting took place as a result of several factors, including Sachs's continued urgings for greater support, the reports of promising progress in the nuclear experiments at Columbia and elsewhere, and an ominous turn of events in the war of Europe. Since the first meeting in October 1939, the atomic scientists had proven definitely that fission occurred only in the U–235 isotope and, in experiments with the centrifuge system of isotopic separation at the University of Virginia, had been successful in enriching a gram of uranium to 10 percent U–235. In Europe, the Germans had successfully invaded Norway in early April and, as a result, secured control of the Norsk Hydro plant, the only large facility in the world producing heavy water. Thus they had obtained a ready source of the substance they were suspected of using as a moderator to achieve a slow-neutron chain reaction.

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[13] Min, Wesson Confs: Jan–Jun 40, 15 Jan 40, Ord Historical Files, Hist Br, OCO.

[14] Memo, Briggs to Watson, sub: Your Memo of Feb 8th, 20 Feb 40, Exhibit 6b, Sachs History, MDR; Min, Wesson Confs, 15 Jan 40, OCO; Enrico Fermi, "Physics at Columbia," *Physics Today* 8 (Nov 5): 15.

[15] Sachs History, pp. 11–12; Ltrs, Einstein to Sachs (source of quotation), 7 Mar 40, Exhibit 7a, Sachs to President, 15 Mar 40, Exhibit 7b, Watson to Sachs, 27 Mar 40, Exhibit 7c, ibid.; Szilard Documents, pp. 8–9, MDR.

Chairman Briggs, Colonel Adamson, and Commander Hoover now listened more sympathetically to the arguments presented by Alexander Sachs, Enrico Fermi, George Pegram, Leo Szilard, Eugene Wigner, and Rear Adm. Harold G. Bowen, director of the Naval Research Laboratory. While the committee still did not make any formal recommendations, it reached general agreement that nuclear research should be vigorously pursued, even if this required large sums of money, and that steps should be taken, as Szilard strongly urged, to halt further publications on atomic matters.[16]

Developments in May 1940 in the laboratory and on the war front brought further justification for providing additional funds for nuclear research. Promising results at Columbia led scientists there to propose a plan to study methods of uranium isotope separation, hopefully with Navy support, and to establish a large-scale experimental program that would demonstrate beyond any doubt that a chain reaction could be maintained in a uranium-graphite system. The Germans' successful invasion of Belgium and Holland in mid-May and new reports on their interest in uranium research underlined Sachs's efforts to secure action on control of Belgian uranium and to obtain financial and administrative support for atomic research in the United States.[17]

New funds came from a variety of sources. On 23 May, the Carnegie Institution of Washington allotted $30,000 for research on uranium by members of its own staff. A short time later, Colonel Adamson furnished $20,000 from Army Ordnance funds to combine with a substantially larger contribution from the Navy and some money from the Bureau of Standards, making a total of more than $100,000. This amount was more than sufficient to underwrite contracts at Columbia and the University of Virginia and to increase support of the work at the Naval Research Laboratory.[18]

German occupation of Belgium gave urgency to the question of how the United States could control and acquire the rich uranium ore in the Congo. Seeking a solution, Alexander Sachs met with President Roosevelt at the end of May and, a few days later, also with Uranium Committee Chairman Briggs, Professor Harold C. Urey, a chemist on the staff at Columbia University, and Admiral Bowen of the Naval Research Laboratory. At

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[16] Smyth *Report*, p. 33, errs in giving the date of the Uranium Committee's second meeting as 28 April. Sachs History, pp. 12–20, MDR; Szilard Documents, pp. 9–10, MDR; Testimony of Gunn in *Atomic Energy Hearings on S. Res. 179*, pp. 367 and 370; Ltr, Pegram to Bowen, 7 Apr 40, Incl I to Adelman Fission Memo, CMH; William L. Laurence, *Men and Atoms: The Discovery, the Uses, and the Future of Atomic Energy* (New York: Simon and Schuster, 1959), pp. 73–74.

[17] Sachs History, pp. 20–25, MDR; Szilard Documents, p. 10, MDR; Ltr, Pegram to Briggs, 6 May 40, Incl K to Adelman Fission Memo, CMH; Laurence, *Men and Atoms*, p. 41.

[18] James Phinney Baxter 3rd, *Scientists Against Time*, Science in World War II (Boston: Little, Brown and Co., 1946), p. 423; Adelman Fission Memo, p. 6 and Incls A–E, CMH; MDH, Bk. 1, Vol. 4, "Auxiliary Activities," pp. 12.2–12.3, DASA; Adamson Interv, 22 Apr 60, CMH; Ltr, Adamson to Campbell, 26 Jun 44, CMH; Testimony of Gunn in *Atomic Energy Hearings on S. Res. 179*, pp. 367–71; Smyth *Report*, p. 33; Compton, *Atomic Quest*, p. 29.

Briggs's suggestion, Sachs began looking into the possibility of getting uranium directly from the Congo.

For some time Sachs had been aware that Edgar Sengier was in New York. Managing director of Union Miniere du Haut Katanga, the Belgian firm that controlled the Shinkolobwe mine in Katanga Province of the Congo, Sengier had come to New York from Brussels in the fall of 1939, aware of the rising importance of uranium from conversations with French and British scientists. He had ordered shipped to America all radium held by his firm in Belgium—some 120 grams worth nearly $2 million. At the same time, he had directed that uranium ores stocked by Union Miniere at Oolen, Belgium, also be shipped to the United States, but little or none was sent before the German invasion made it impossible.

Sachs and Urey went to see Sengier in New York in early June 1940. Sengier gave them considerable information on the status of Congo uranium but would not agree to Sachs's proposal that Union Miniere ship ore to the United States, even with the stipulation that U.S. officials would not re-export the ore without special permission.[19]

Failure to achieve an agreement with Sengier left the uranium research program dependent upon Canadian sources. Fortunately, by the end of 1940, small amounts of Canadian uranium were available as a result of arrangements based on earlier conversations between Dean George B. Pegram of Columbia University and a representative of Eldorado Gold Mines, Ltd., owner of the Canadian deposits.[20]

Funds contributed in the summer of 1940 began a two-year period of rapid growth in the program to exploit atomic energy for military purposes. During this time, American governmental leaders left development of the new energy source to civilian organizations, in spite of its obvious application to military objectives and its close relationship to the expanding conflict in Europe and Asia. Army participation ceased almost completely, and the Navy continued only a relatively small isotope separation project. Under civilian guidance, the work on atomic energy became a major component in the federal government's greatly broadened program to apply the achievements of American science to the requirements of modern warfare. Thus, by early 1942, when the Army renewed its participation in the development of atomic energy, the program had evolved into a large research and development enterprise, with civilian scientists carrying on program activities at a number of sites across the country.

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[19] Sachs History, pp. 25–26, MDR; Ltrs, Sachs to Watson, 23 May 40, Exhibit 11a, and Briggs to Sachs, 5 Jun 40, Exhibit 18, ibid.; Leslie R. Groves, *Now It Can Be Told: The Story of the Manhattan Project* (New York: Harper and Brothers, 1962), pp. 33–34; Compton, *Atomic Quest*, p. 96; Smyth *Report*, p. 33; Richard G. Hewlett and Oscar E. Anderson, Jr., *The New World, 1939–1946*, A History of the United States Atomic Energy Commission, Vol. 1 (University Park, Pa.: Pennsylvania State University Press, 1962), p. 26.

[20] Memo, Szilard to Briggs, sub: Possibility of Large-scale Experiment in Immediate Future, 26 Oct 39, Incl to Szilard Documents, MDR; Supreme Court of the State of New York, *Eldorado Mining and Refining* (formerly Eldorado Gold Mines) vs. *Boris Pregel* et al., Statement to Pregel, 18 Oct 46, Investigation Files, Gen Corresp (Boris Pregel), MDR; MDH, Bk. 7, Vol. 1, "Feed Materials and Special Procurement," pp. 3.1–3.3, DASA.

Establishment of the NDRC and OSRD

The organizational framework of the American atomic energy program first began to take shape in the summer of 1940. In June, a number of the scientific leaders took the initiative in providing a more effective administrative organization. At Leo Szilard's suggestion and with the backing and approval of Admiral Bowen and Lyman Briggs, Harold Urey organized a committee of scientists to advise Briggs on atomic energy and to study the question of security. This group, the Advisory Committtee on Nuclear Research, met for the first time on the thirteenth under Urey's chairmanship. One of its first actions was to formulate, with support of American scientific journals, a policy on secrecy that eventually halted publication of scientific papers on atomic energy in the United States. Thus, a beginning was made in solving what was to become another major and persistent problem—how to maintain a level of secrecy hitherto never attempted in so large and diverse a project.[21]

Even as the Advisory Committee on Nuclear Research was meeting, events were taking place that would increase effective leadership and direction for the entire American scientific war effort, including the atomic energy program. Since the invasion of Belgium, Sachs had been urging Roosevelt to establish a "Scientific Council of National Defense" to administer "the testing and execution of technical projects of utility for national defense." Another strong advocate for such a council was Vannevar Bush, president of the Carnegie Institution of Washington since 1939.[22] For some time he had discussed his ideas with several of the nation's foremost scientists and had gained their support for the project. In addition, the country's military leaders, including both Army Chief of Staff General George C. Marshall and Chief of Naval Operations Admiral Harold R. Stark, strongly favored the proposal. Consequently on 15 June 1940, the President established the National Defense Research Committee (NDRC), with Bush as chairman, to direct, coordinate, and carry out a national program of military research and development. Membership was drawn from the National Academy of Sciences, with Brig. Gen. George V. Strong, chief of the War Plans Division, representing the Army and Rear Adm. Harold G. Bowen, director of the Naval Research Laboratory, representing the Navy.

With establishment of the NDRC, the President made provision for continuation of the atomic energy program. He asked Vannevar Bush to reconstitute the original Uranium Committee as a subcommittee of the NDRC. The new Committee on Uranium, reporting to Bush and with Briggs continuing as its chairman, included six other scientists but lacked the service representation that the original committee had. Briggs was authorized "to maintain close and direct contact with those officers of the Army and Navy most directly interested," but only Ross Gunn of the Naval Research Laboratory continued to serve on the new committee.[23]

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[21] Szilard Documents, pp. 10–11, MDR; Ltr, Urey to Szilard, 7 Jun 40, Incl to ibid.

[22] Sachs History, p. 24, MDR; Ltr, Sachs to Watson (source of quotation), 15 May 40, Exhibit 15a, ibid. Bush enjoyed a distinguished career in applied mathematics and electrical engineering at MIT in the two decades following WW I and achieved a reputation as a scientific administrator of great skill.

On 1 July, Briggs reviewed for Bush the earlier activities of the Committee on Uranium. At the same time, he requested the $140,000 that he and Urey's Advisory Committee had agreed was necessary for purchasing uranium metal and pure graphite and for making further measurements of the fundamental nuclear constants. At its first formal meeting the next day, the NDRC considered Briggs's request, but its members found themselves in a dilemma. The basic NDRC mission was research and development of weapons and equipment with direct application to the war. NDRC scientists still regarded the chances of an atomic weapon as "very remote," in Bush's words, and even the possibility of nuclear power for battleships or submarine propulsion seemed a distant eventuality at best. Given the need for funds and trained scientists in other areas, there was grave doubt as to the wisdom of allocating money and energy to "what might eventually appear to have been wild research." Yet, there was a danger that German nuclear research might prove successful. Committee members concluded, therefore, that prudence demanded acquisition of knowledge of the fundamental physics of atomic energy. Accordingly, the NDRC approved Briggs's request in principle and asked him for further definite proposals for "a careful, but not elaborate or expensive program." [24]

Promise of NDRC funds opened the way for the future rapid expansion on atomic research in the United States. But until these new funds became available, the atomic program had to continue to draw upon money supplied earlier by the Army and the Navy. Even the $40,000 for the first NDRC contract for atomic research, an agreement signed with Columbia University in early November, came out of the remaining Army-Navy funds.

Beginning with the NDRC's allotment on 25 October of the $140,000 requested by Briggs on 1 July, there followed a series of contracts and transfer agreements arranging for nuclear research by various institutions. By the spring of 1941, the NDRC had committed nearly $500,000 for work at Columbia, Harvard, Princeton, the University of Minnesota, the Standard Oil Development Company, Iowa State College, Cornell, the University of Chicago, Johns Hopkins, the Carnegie Institution of Washington, the University of California (Berkeley), the University of Virginia, the Bureau of Standards, and the Department of Agriculture. While the NDRC's expenditure for atomic energy was small compared with amounts allotted to other wartime scientific research, it represented a significant financial boost for the American program. As Alexander Sachs observed a few years later, the program had become "invested with the importance, the resources and the secrecy available to the Government of the United States . . . for the translation of the idea into a reality. . . ." [25]

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[23] Quoted words from Ltr, Roosevelt to Briggs, 15 Jun 40, Exhibit 19, Sachs History, MDR. Baxter, *Scientists Against Time*, pp. 12–16; Ltr, Roosevelt to Bush, 15 Jun 40, HLH; Watson, *Chief of Staff*, pp. 49–59; Smyth *Report*, p. 34.

[24] Quoted words from National Defense Research Committee Report for First Year of Operation, 27 Jun 40–28 Jun 41 (hereafter cited as NDRC Rpt, 1940–41) pp. 34–35, Incl to Ltr, Bush to President, 16 July 41, FDR. Szilard Documents, pp. 10–11, MDR; Irvin Stewart, *Organizing Scientific Research for War*, Science in World War II (Boston: Little, Brown and Co., 1948), pp. 120–21 and 230; Baxter, *Scientists Against Time*, pp. 423–24.

While the NDRC was able to focus the energy and capabilities of civilian scientists on many aspects of military technology, it left certain gaps in the program to mobilize American science for war. Hence, at the end of June 1941, President Roosevelt established the Office of Scientific Research and Development (OSRD), with the NDRC as one of its subordinate agencies. Bush became OSRD director and James B. Conant, president of Harvard University, succeeded Bush as NDRC chairman. In this reorganization the Committee on Uranium under Briggs remained within the NDRC, but it was somewhat enlarged and was renamed the Section on Uranium. Again it included no Army or Navy representatives, and even Ross Gunn of the Naval Research Laboratory was no longer a member. [26]

New Advances in Atomic Research, 1940–1941

In mid-July 1941, enthusiastic over reports that atomic scientists in America and Great Britain were making significant progress in atomic research, Vannevar Bush reported to the President that "new knowledge" made "it probable that the production of a super-explosive may not be as remote a matter as previously appeared." [27] At Columbia, supported by investigations at Princeton and the Universities of Chicago and California (Berkeley), researchers produced sufficient favorable data on the capture cross sections for the neutrons of U–235 and U–238 and on the absorption qualities of graphite to justify construction in July 1941 of the first lattice pile—a large graphite cube in which containers of uranium oxide were distributed at equal intervals. The research results also convinced many more scientists that a chain reaction in a uranium-graphite system eventually would be achieved.

At Berkeley, physicists working with Ernest O. Lawrence on the bombardment of uranium with neutrons discovered that the capture of fast neutrons by U–238 transmuted that isotope first into element 93 and then into element 94, which they named neptunium and plutonium, respectively. After further investigation of these transuranium elements, neither of which was then known to exist in nature, Lawrence's group concluded that plutonium had the same fission characteristics as U–235; it could be split by neutrons and would, in turn, release more neutrons. U–238, hitherto regarded as worthless for energy purposes, was in fact a prime source.

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[25] Quoted words from Sachs History, p. 27, MDR. Smyth *Report*, pp. 34–35; Stewart, *Organizing Scientific Research for War*, pp. 121 and 123; Baxter, *Scientists Against Time*, p. 424; Testimony of Gunn in *Atomic Energy Hearings on S. Res. 179*, pp. 367 and 371.

[26] Stewart, *Organizing Scientific Research for War*, pp. 34–40 and 121; Smyth *Report*, p. 35.

[27] NDRC Rpt. 1940–41, p. 35, Incl to Ltr, Bush to President, 16 Jul 41, FDR. Except as indicated, following section on progress of atomic research in the United States during 1940–41 based on Smyth *Report*, pp. 26, 36, 38–41, 47–49.

ERNEST O. LAWRENCE, ARTHUR H. COMPTON, VANNEVAR BUSH, AND JAMES B. CONANT *(left to right), four of the Manhattan Project's scientific leaders (1940 photograph)*

Furthermore, as there was reason to believe that chemical separation of plutonium from uranium might prove more practicable than isotopic separation of U-235 from U-238, chances that an atomic bomb based on a fast-neutron chain reaction could be built were tremendously increased.

American atomic scientists learned of encouraging British developments on isotopic separation by gaseous diffusion and on heavy water as a moderator in a slow-neutron chain reaction system through a scientific information exchange program, begun in the fall of 1940. With the support of the War and Navy Departments, NDRC members conferred informally with British scientific representatives, both in the United States and in England, achieving a limited exchange of data about the progress of nuclear research in each country.[28]

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[28] See Ch. X for discussion of a formal program of information interchange with Great Britain on nuclear matters. Margaret Gowing, *Britain and Atomic Energy, 1939-1945* (London: Macmillan and Co., St. Martin's Press, 1946), pp. 115-26; J. G. Crowther and R. Whiddington, *Science at War* (London: His Majesty's Stationery Office, 1947), pp. 143-46; H. Duncan Hall and C. C. Wrigley, *Studies of Overseas Supply*, History of the Second World War (London: His Majesty's Stationery Office, 1956), pp. 358-85 and 405-13; Sir George Thomson, "Anglo-U.S. Co-operation on Atomic Energy," *American Scientist* 41 (Jan 53): 78.

In the summer of 1941, a special reviewing committee of the National Academy of Sciences supported Bush's optimism. The committee, established at Briggs's suggestion that an impartial evaluation of the atomic program was needed, first met in May under the chairmanship of Arthur H. Compton, head of the physics department and dean of the Division of Physical Sciences at the University of Chicago. The committee's initial report was buttressed by supporting remarks from Briggs, and on 18 July the NDRC approved contracts and transfers amounting to nearly $400,000 for chain reaction, nuclear power, and isotope separation research. While the NDRC remained cautious in its estimate of whether atomic energy could be harnessed in time to affect the outcome of the war, it recognized that continued progress in nuclear research would eventually require establishment of a long-range program so vast and expensive that in wartime only the Army or Navy could carry it out.[29]

The pressure of an all-out attack on the problem of atomic energy grew rapidly. At the University of California, Lawrence was more and more convinced of the feasibility of using plutonium to make an atomic bomb and he communicated his enthusiasm to both Compton and Conant. Compton was especially interested and he, in turn, talked with other nuclear researchers. From Urey and physicist John Dunning, who also was on the staff at Columbia, he learned of progress on isotope separation, and from Fermi he received encouraging news of the results of experiments with the lattice pile. Most of the scientists now involved felt that the atomic energy program should be pushed, and in mid-October, at Conant's suggestion, Compton reconvened his reviewing committee, now somewhat enlarged, to prepare another report.[30]

On 3 October, Bush received the first official copy of a British review of atomic energy that had been completed in mid-July, but he was not yet at liberty to disclose its contents to the NDRC. The British scientists had optimistically concluded that a uranium bomb could be built with an explosive power of 1,800 tons of TNT. They indicated a rough idea of its critical mass and possible methods of assembly and fusing. They thought the gaseous diffusion method offered the best answer to the problem of separating a sufficient amount of U-235 and the uranium-heavy water system gave promise as a means for producing power and plutonium.[31]

Top Policy Group: Preparing for Army Take Over

Increasing conviction that atomic bombs were feasible prompted Bush to take immediate steps to obtain the high-level policy decisions he had foreseen would be necessary to assure aggressive pursuit of the uranium program. On 9 October 1941, almost two years to the day on which Alexander Sachs first informed the President about atomic energy, Bush had a long conversation with Roosevelt and Vice President Henry A. Wallace. In late July, Bush and Wallace had discussed the progress of the American program; now, supported with more concrete evidence of possible success at hand, they were considering what the President could do to further develop the program. The OSRD director outlined the current status of research in both the United States and Great Britain, pointing up the general optimism of the scientists in both countries but, at the same time, emphasizing that their predictions could not be guaranteed. He indicated, too, that much work would be required before success could be anticipated.

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[29] Baxter, *Scientists Against Time,* pp. 424–26; Compton, *Atomic Quest,* pp. 45–49; Smyth *Report,* pp. 35 and 49; Stewart, *Organizing Scientific Research for War,* p. 121; Hewlett and Anderson, *New World,* pp. 36–43.

[30] Compton, *Atomic Quest,* pp. 6–9 and 53–56; Smyth *Report,* p. 36; Hewlett and Anderson, *New World,* pp. 45–49.

[31] Smyth *Report,* p. 36; Crowther and Whiddington, *Science at War,* pp. 144–45; Thomson, "Anglo-U.S. Cooperation," pp. 78–79; Gowing, *Britain and Atomic Energy,* pp. 83–86 and 116–17.

President Roosevelt agreed that the atomic energy program must be provided with a better organization and more funds and that arrangements should be made for a complete interchange of information with the British. He directed formation of what was informally designated the Top Policy Group, to be headed by himself—although he never actually participated in its proceedings—and to consist of Vice President Henry A. Wallace, Secretary of War Henry L. Stimson, Army Chief of Staff General George C. Marshall, Vannevar Bush, and James B. Conant.[32] Thus the President took the first step in implementing a maximum effort to develop an atomic bomb as soon as possible. He also decided that the Army, and not the Navy, would be given the primary responsibility for attaining this goal.

The NDRC had concluded that no private institution or relevant government agency had the means or personnel to carry out the extraordinarily large tasks of plant construction and administering development of a nuclear weapon. The choice, then, was the Army or the Navy. When Roosevelt appointed Secretary Stimson and General Marshall to the Top Policy Group that had no naval representation, he decided in effect that the Army was to manage the job. Why had the President selected the Army when the Navy had exhibited much greater interest in nuclear research? Indications are that Bush and his associates had decided that the Army was the more appropriate choice for the project. The end product was to be a bomb, presumably delivered by an Army bomber. Also the Army, judged on the basis of its past experience and its organization, appeared better fitted to undertake the vast construction program.[33]

The President also had agreed to establish an effective exchange of information with the British. On 11 October he communicated with Prime Minister Winston S. Churchill, suggesting that they correspond or talk about atomic developments, inaugu-

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[32] Baxter, *Scientists Against Time*, p. 427; Smyth *Report*, p. 37; Ltr, Bush to President, 9 Mar 42, HB Files, Fldr 58, MDR.

[33] Col. James C. Marshall, who would head the new Army engineer district that would administer the atomic bomb program, reported that Bush, in the fall of 1942, told him and other Army officers that the Navy "had been left out of the present project at the explicit direction of the President." See Marshall Diary, 21 Sep 42, MDR. The Navy, nevertheless, would continue to support research already under way on liquid thermal diffusion. See Ch. VIII.

SECRETARY OF WAR HENRY L. STIMSON

rating a period of regular interchange between the two countries.[34]

The President's efforts to strengthen the American atomic energy program were reinforced a few weeks later by Compton's National Academy reviewing committee. On 6 November, the committee issued another report that, while not as optimistic as the earlier British study, nevertheless constituted a strong endorsement of an expanded atomic bomb program. Because Compton's group had prepared its report without access to the British conclusions—Bush up to now had been bound not to disclose them—its findings consisted of both a further verification of the British views and an independent recommendation.

The committee report stated that "within a few years . . . military superiority" might be determined by U-235 bombs and that building these bombs seemed "as sure as any untried prediction based upon theory and experiment can be." The amount of U-235 needed for each bomb would be between 2 and 100 kilograms, producing an explosive energy per kilogram of U-235 equal to that of about 300 tons of TNT and a destructive effect equivalent to about 30 tons of TNT. Atomic bombs could thus be of "decisive importance" in defeating Germany and, based on an estimate that military and industrial targets in Germany could be devastated with 500,000 tons of TNT bombs, from 1 to 10 tons of U-235 would be needed to do the same job. This much U-235 could be obtained, continued the report, by one or more methods of isotope separation, of which the gaseous diffusion and centrifuge methods appeared to be furthest along in development. In accordance with instructions from Bush, the committee did not discuss plutonium and it purposely played down the expense of producing U-235 bombs to avoid arousing government fears of excessive costs. "If all possible effort is spent on the program," the report concluded, "fission bombs" might "be available in significant quantity within three or four years."[35]

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[34] Ltr, Roosevelt to Churchill, 11 Oct 41, FDR; Churchill's reply quoted in Msg, Prime Minister to Harry L. Hopkins, 27 Feb 43, HLH; Crowther and Whiddington, *Science at War*, p. 146; Smyth *Report*, p. 37. For detailed discussion of efforts to establish effective interchange in late 1941 see Ch. X.

This prediction came at a time when only infinitesimal amounts of plutonium had been produced and when no appreciable quantity of U–235 had been separated from U–238, no large amounts of uranium metal or moderators produced, and, as yet, no chain reaction achieved. Nevertheless, the committee report, as had its British counterpart, reflected the substantial progress that had been made in research. Although some scientists were still no more convinced that atomic weapons were imminently possible than they had been a year earlier, the threat of American involvement in war now seemed far stronger, with the result that large expenditures of money and effort were no longer seen as extravagances but rather as necessary precautions.

Bush's first action after receiving Compton's committee report was to show it to Secretary of War Stimson. Whether the 6 November meeting was Stimson's first word of his appointment to the Top Policy Group is not clear, but there is no doubt about his reaction to the awesome possibilities of an atomic bomb. "A most terrible thing," he called it, sensing the grave responsibility falling upon those who would unleash the power of such a devastating weapon.[36]

During the next few weeks, Bush apparently reviewed the entire American atomic energy program and, in compliance with the President's instructions, devised a plan for an administrative reorganization designed to expedite efforts "in every possible way."[37] Finally, on 27 November, Bush forwarded the report of Compton's reviewing committee to Roosevelt and, presumably, his own recommendations for the new organization. The NDRC endorsed these recommendations on the twenty-eighth. Then on 6 December 1941, the day before the Japanese attack on Pearl Harbor, Conant—speaking for Bush—announced the details of the new organization to those persons who would now join together in a maximum effort to develop an atomic bomb.

Under the new organization, the atomic energy program was divorced from the NDRC and placed under the immediate supervision of Bush as the OSRD director. Bush reported directly to the President, at the same time keeping Vice President Wallace and Secretary Stimson fully informed. The scientific group under Bush was now called the OSRD S–1 Section, dropping the word *uranium* for security reasons. Its function was to recommend and coordinate action on nuclear research, ensure that authorized assignments were carried out, and, within six months, prepare a final

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[35] Both quotations from Rpt, Academy Committee on Uranium, sub: Rpt to President of the Natl Academy of Sciences, 6 Nov 41, OSRD. Portions of the report are reproduced in the following sources: Smyth *Report*, pp. 49–52; Smyth Ms (containing some material not included in final version), Admin Files, Gen Corresp, 319.1 (Smyth Rpt), MDR; Compton, *Atomic Quest*, pp. 56–59; Baxter, *Scientists Against Time*, pp. 426–28.

[36] Diary of Henry L. Stimson (hereafter cited as Stimson Diary), 6 Nov 41, HLS; Henry L. Stimson, "The Decision To Use the Bomb," *Harper's* 194 (Feb 47): 98–99; Compton, *Atomic Quest*, p. 59.

[37] Ltr, Bush to President, 9 Mar 42, MDR.

report on the feasibility of building atomic bombs.

Conant, acting as Bush's representative, had oversight of the whole program. Briggs stayed on as chairman of the S-1 Section, with Dean Pegram of Columbia as vice chairman and a number of outstanding scientists serving as consultants. In addition, three program chiefs, each a Nobel Prize winner, were in charge of three distinct programs in physics. Arthur H. Compton of the University of Chicago headed the program of basic physics studies and measurements of nuclear properties pertinent to the chain reaction. His program also included exploring the problem of plutonium production by means of the controlled fissioning of uranium. Ernest O. Lawrence of the University of California, Berkeley, had responsibility for producing the first small samples of fissionable elements, isotope separation by the electromagnetic method, and experimental work on the properties of plutonium. Finally, Harold C. Urey of Columbia University had charge of isotope separation by the diffusion and centrifuge methods, as well as research on heavy water production.

To supervise engineering procurement and production plant construction—activities that Bush and his associates knew must shortly be turned over to the Army—the OSRD director set up a planning board, headed by Eger V. Murphree, vice president of the Standard Oil Development Company, an affiliate of Standard Oil Company (New Jersey). The OSRD would enter into and finance all contracts negotiated in support of the reorganized atomic energy program. The board would make recommendations to Bush concerning those contracts for engineering, for development of the diffusion and centrifuge processes, and for the heavy water program. Briggs and Conant, with the interested program chiefs, would recommend all other contracts. When the Army took over administration of much of the atomic energy program, many OSRD contracts had to be renegotiated.[38]

America's entry into World War II hastened the move for the Army to take over the primary direction and control of the bomb development project. Concrete steps to bring about this change came up for discussion at a meeting of the Top Policy Group called by Vice President Wallace on 16 December. In attendance were Secretary Stimson, Bush, Wallace, and, in addition, Harold D. Smith, director of the Budget Bureau. Conant and General Marshall were unable to attend. According to Secretary Stimson, that meeting was significant. The group discussed, he recorded, "some of the new inventions, many of them diabolical, that are coming out of the Scientific Research Commission" [NDRC] and "decided to go ahead with certain experiments." Bush himself noted the group's strong opinion "that OSRD should press as fast as possible on the construction of pilot plants." [39] He estimated this aspect of the work would cost $4 to $5 million and stated that the Army should take over when full-scale construction began, presumably when the pilot plants were ready. He recommended that a suitably trained Army officer should familiarize himself with the general nature of the program.

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[38] Ibid. and Incl; Smyth *Report*, pp. 53-55; Baxter, *Scientists Against Time*, p. 428; Compton, *Atomic Quest*, pp. 62-63 and 68-78; Stewart, *Organizing Scientific Research for War*, pp. 121-22; Hewlett and Anderson, *New World*, pp. 40-51; Charles Sterling Popple, *Standard Oil Company (New Jersey) in World War II* (New York: Standard Oil Co., 1952), p. 295.

[39] Stimson Diary, 16 Dec 41, HLS; Bush quoted in Smyth *Report*, p. 55.

The Top Policy Group then approved Bush's reorganization of the atomic energy program and his plans and recommendations for action. They also agreed that the international aspects were clearly a presidential responsibility, with Bush's function limited to liaison solely on technical matters.[40]

Progress in Research and Development: The Nuclear Steeplechase

Two days later, on 18 December, the new OSRD S-1 Section held its first meeting, a session "pervaded by an atmosphere of enthusiasm and urgency."[41] Conant explained again the decision to proceed with the development of the bomb and stressed the necessity of a maximum effort. His words were seconded by Urey and Pegram, recently returned from England, who described British progress on the gaseous diffusion method of isotope separation and in experiments with heavy water. They also emphasized that Britain greatly feared Germany might produce atomic bombs before the Allies. Probably the most enthusiastic presentation was Lawrence's description of his success in testing the electromagnetic method as a possible process for separating uranium isotopes. As a member of Compton's reviewing committee the previous summer, Lawrence had become convinced of the great potentialities of this method in spite of the widely prevailing belief among scientists that the so-called space charge limitation—mutual repulsion of ions, making sharp focus of a beam of particles impossible—made it impractical for large-scale separation. Lawrence asserted that experiments at his Berkeley-based Radiation Laboratory with the mass spectrograph proved that the technical difficulties that tended to reduce the efficiency of the electromagnetic process could be overcome.[42]

A 184-inch cyclotron magnet, nearly five times wider than the 37-inch magnet used for previous experiments, had been under construction at the University of California, Berkeley, funded by the Rockefeller Foundation. Work had stopped because of the war, but now an extra appropriation from the foundation permitted Lawrence to complete the project by the end of May 1942, providing a means, as Lawrence wrote later, that "made it seem possible that we might be able to get somewhere . . . in time to be of value in this war."[43]

With the Radiation Laboratory researchers concentrating increasingly on electromagnetic separation, most of the work on plutonium was left to Compton's University of Chicago group that was investigating the feasibility of achieving a chain reaction. In January 1941, Compton decided to move the scientists working under his supervision at Columbia and Princeton to the University of Chicago. By early February, he concentrated the various research and development activities under what was called, for security reasons, the Metallurgical Laboratory. Compton's group devoted itself henceforth to three main tasks: achievement of a chain reaction; study of the chemistry of plutonium, including development of a means for separating it from uranium; and the design of plutonium-producing piles. Because these tasks depended upon an adequate supply of uranium and graphite, representatives of the Metallurgical Laboratory also actively supported the S-1 Section's planning board in the procurement program, contributing much to its success.[44]

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[40] Smyth *Report*, p. 55; Ltr, Bush to President, 9 Mar 42, MDR; Hewlett and Anderson, *New World*, pp. 51–52.

[41] Smyth *Report*, p. 55.

[42] Rpt, W. M. Brobeck and W. B. Reynolds, sub: On Future Development of Electromagnetic System of Tube Alloys Isotope Separation, 15 Jan 45, OCG Files, Gen Corresp, Groves Files, Fldr 10, MDR; Compton, *Atomic Quest*, pp. 76–77; Hewlett and Anderson, *New World*, pp. 56–57.

[43] Ltr, Lawrence to Warren Weaver (Natural Sciences Div Dir, Rockefeller Foundation), 20 Aug 45, Admin Files, Gen Corresp, 201 (W), MDR; Smyth *Report*, pp. 46, 49, 55, 136–40; Compton, *Atomic Quest*, pp. 73–74.

At the same time, research on the gaseous diffusion process and on the production of heavy water went forward under Harold Urey's direction at Columbia, and investigations on the centrifuge method of separation progressed under the general supervision of Eger Murphree at the University of Virginia, where physicist Jesse W. Beams directed the program, and at the Standard Oil Development Company in New Jersey, where research begun earlier at Columbia was continued.

Work was also proceeding on still another separation method, liquid thermal diffusion, based on the tendency of one of two isotopes in a fluid to concentrate near the hotter of two opposing surfaces. Philip H. Abelson had started research on this process at the Carnegie Institution but later moved to facilities at the Naval Research Laboratory. While development of the thermal diffusion process was not a part of the OSRD program, it would prove highly useful to the atomic project at a later date.[45]

Thus the OSRD was at work simultaneously on five methods of producing fissionable materials—three isotope separation processes (electromagnetic, gaseous diffusion, and centrifuge) for producing U-235 and two pile processes (uranium-graphite and uranium-heavy water) for manufacturing plutonium—projects Conant referred to as five "horses" in a race.[46] Choosing a favorite and predicting an outcome, however, were almost impossible because any one of the horses might encounter insurmountable obstacles. Although concentrating all resources on the most promising horse would have been more efficient and economic, playing this odd just might have enabled Germany to be the first to build an atomic bomb.

In support of this nuclear steeplechase, the OSRD, by early February 1942, had entered into ten contracts with twelve institutions totaling more than $1 million, figures that roughly doubled in the next month. On the twentieth, Conant recommended that all five methods "be pushed vigorously" until 1 July, by which time he hoped many of the contracts could be dropped or revised in accordance with whatever progress had been made. Indeed, Conant continued, if by then the electromagnetic method of separation demonstrated a clear capability "of producing grams per day," work on other methods of producing fissionable materials might be dropped or at least continued at a slower pace. Furthermore, even if all five horses had to be kept running "at full speed down the course" until the beginning of 1943, the OSRD research program might still be completed for between $10 and $17 million.[47]

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[44] Smyth *Report*, pp. 56 and 63-65; Compton, *Atomic Quest*, pp. 80-98.

[45] Smyth *Report*, pp. 47 and 56; Testimony of Gunn in *Atomic Energy Hearings on S. Res. 179*, pp. 367-68.

[46] In his account of the development of alternate methods for producing fissionable materials in early 1942, Compton counted only four "horses" in the race, perceiving the two pile processes as a single method. See *Atomic Quest*, pp. 77-78.

The "intense scientific research and engineering planning now underway" was the subject of a guardedly optimistic progress report that Bush submitted to the President on 9 March. "The possibility of actual production appears more certain," he wrote, but "the way to full accomplishment is still exceedingly difficult." A full-scale effort might achieve completion of the project in 1944, or possibly six months sooner, and success for either the Allies or the enemy could "be determining in the war effort." Bush pointed out that the work was "rapidly approaching the pilot plant stage," with selection of the best methods of production not too far off. The summer of 1942, he believed, would "find the matter ready to turn over to Army control, for actual production plant construction." A further reason for transferring "the whole matter . . . to the War Department," Bush added, was the necessity for instituting tight security measures once actual production began.[48]

With the Army's entrance into the atomic energy program only a few months off, it was time to assign a suitable officer to follow nuclear developments. For this mission, General Marshall personally chose Brig. Gen. Wilhelm D. Styer, chief of staff of the Services of Supply (SOS). A graduate of the U.S. Military Academy, with an additional degree in civil engineering from Massachusetts Institute of Technology and two decades of experience as a Corps of Engineers officer supervising various kinds of construction projects, Styer was well qualified to lay the groundwork for Army participation in the atomic energy program. He immediately began an intensive study of the project, in close coordination with Bush and the S–1 Section. Despite the demands of his SOS duties, from this point until his departure for an overseas assignment late in the war, General Styer would play an important part in the Army's effort to produce an atomic bomb.[49]

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[47] Conant's words as quoted in Baxter, *Scientists Against Time*, p. 433; Smyth *Report*, p. 56; Rpt to President, sub: Status of Tube Alloys Development, 9 Mar 42, Incl to Ltr, Bush to President, same date, MDR.

[48] Ltr, Bush to President, 9 Mar 42, MDR.

[49] 1st Ind, Styer to Chief of Mil Hist, 15 Aug 61, to Ltr, Chief of Mil Hist to Styer, 17 Jul 61, CMH; Memo, Bush and Conant to Wallace, Stimson, and Marshall, sub: Atomic Fission Bombs, 13 Jun 42, Incl to Ltr, Bush to President, 17 Jun 42, HB Files, Fldr 6, MDR (cf. Ltr, Bush to President, 9 Mar 42, and Incl, MDR). On Styer, see John D. Millett, *The Organization and Role of the Army Service Forces*, U.S. Army in World War II (Washington, D.C.: Government Printing Office, 1954), pp. 5, 32, 369, and passim; Cullum, *Biographical Register*, 6B:1806, 7:1121–22, 8:306, 9:207.

Meanwhile, the five horses were in the running, four of them neck and neck, with a fifth one now bidding to join the race. This was the alternate method of producing plutonium by using heavy water instead of graphite as the moderator in a chain reaction pile, a process strongly championed by Urey. As work approached the pilot plant stage, the need to concentrate on one or more of these horses was becoming increasingly apparent. To conserve time design and construction of actual production plants should begin even before the pilot plants were finished. However, Conant believed there was "a desperate need for speed" to build the bombs before the Germans could and he only solution was to go ahead on all five.[50]

On 23 May, S-1 Section Chairman Lyman Briggs met with Compton, Lawrence, Urey, and Murphree to make final recommendations on the program. In a report submitted to Bush two days later, the group concluded that practical atomic bombs of either U-235 or plutonium, with an energy release equal to that of several thousand tons of TNT, were definitely feasible. Underestimating the amount of fissionable material later found necessary for each bomb, as well as the time required for development and construction, they believed the bombs would be available in small quantities by about July 1944. They recommended funding of all five methods, although, for reasons advanced primarily by Compton, they gave the uranium-graphite pile a definite priority over the heavy water pile. They also proposed a pilot diffusion plant and preparation of complete engineering designs for a full-scale diffusion installation. They advised constructing a centrifuge plant by January 1944, an electromagnetic plant by late 1943, a plutonium-producing atomic power installation by early 1944, and, as an auxiliary to the latter, heavy water plants by May 1943.

Bush, Conant, and General Styer approved these recommendations and, on 13 June, Bush and Conant submitted them to the Top Policy Group with detailed plans to expand the atomic energy program. They underlined the danger of German success in building an atomic bomb and endorsed the proposal to continue work on all major methods of production. At the same time, they warned that such a course would interfere with other military research and called for careful judgment, when further study made it possible, to achieve a better balance.[51]

Importantly, Bush and Conant recommended that construction of the separation plants and development of the power project be turned over to the Army, specifically "to be in [the] charge of a qualified officer designated by the Chief of Engineers and reporting to him. . . ." They also suggested that this officer be assisted on a full-time basis by leading civilian scientists and engineers, "preferably in the status of officers." [52] Funds for this work—$54 million in fiscal year 1943—should be made available to the Engineers chief who, to avoid delay, should be authorized to spend or overobligate any money under his control with the understanding that he would be reimbursed later. After consulting with the S-1 Section's planning board, the Engineers chief should also begin immediately to let contracts for the detailed design of all plants.

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[50] Quoted in Baxter, *Scientists Against Time*, p. 434.

[51] Ibid., pp. 434–35; Memo, Bush and Conant to Wallace, Stimson, and Marshall, 13 Jun 42, Incl to Ltr, Bush to President, 17 Jun 42, MDR; Smyth *Report*, pp. 56–57; Compton, *Atomic Quest*, pp. 98–103.

[52] Memo, Bush and Conant to Wallace, Stimson, and Marshall, 13 Jun 42, Incl to Ltr, Bush to President, 17 Jun 42, MDR.

Under the Bush-Conant proposals, the OSRD would continue to direct and control research and development, with $31 million directly available for this purpose and an additional $5 million held in reserve for contingencies in the next fiscal year. There would be frequent meetings between representatives of the OSRD and the Corps of Engineers in order to coordinate and report on research, development, and construction. Research and development on the actual military uses of atomic energy would be under the Joint Committee on New Weapons and Equipment of the Joint Chiefs of Staff. In addition, Bush and Conant suggested that sites be selected, priorities established, and close security regulations imposed on the entire project.

With the approval of Vice President Wallace, Secretary Stimson, and General Marshall, Bush forwarded the proposed program to the President on 17 June 1942. "If you also approve," he wrote, "we will proceed along these lines immediately." The President's initials—"OK FDR"—were affixed that day, signaling the decision to go ahead.[53]

The United States was now firmly and fully committed to an all-out effort to build an atomic bomb. From initial skepticism and only casual interest, the attitude of the government had changed gradually to one of active support. The ultimate decision to build the bomb was a presidential one and, as such, had been made at the meeting with Wallace and Bush on 9 October 1941. But laying the groundwork for that far-reaching decision were the intermediate steps taken by Bush and his scientific associates in early December 1941, reinforced by Stimson and Wallace later that month, and confirmed by members of the S-1 Section and the Top Policy Group in the spring of 1942. As for the Army, the President's decision on 17 June brought it back into the atomic bomb program, this time to participate on a far broader scale. Within hours of that decision, the Army designated Col. James C. Marshall, who had nearly twenty-five years as a regular in the Corps of Engineers, to begin the task of organizing and carrying out its vast new assignment as administrator of all construction work for that program.

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[53] Ltr, Bush to President, 17 Jun 42, MDR.

CHAPTER II

Establishing the Manhattan District

Undeterred by the unusual nature of the atomic energy program, the Army Corps of Engineers in June 1942 prepared to carry out its new wartime construction assignment. After his initial conference with Brig. Gen. Wilhelm D. Styer late in the afternoon of the eighteenth, Col. James C. Marshall experienced a certain restlessness as he tried to comprehend the scope of the new task at hand. The next day, he received some of the answers to his many questions when Styer took him to the Office of Scientific Research and Development to call on Vannevar Bush. The OSRD director gave the two officers several documents, among them a copy of the program for continued development of atomic energy that President Roosevelt had approved on the seventeenth. From these papers Marshall learned that the Army was now charged with "all large-scale aspects," [1] as Bush put it, of the atomic energy program, with the OSRD retaining responsibility for scientific research and pilot plant experimentation. The Army's mission included building both pilot and full-scale plants for producing fissionable materials to be used in the manufacture of atomic bombs, letting contracts for these plants and others to be under OSRD direction, and extensive site selection, acquisition, and development—all to be carried out in close coordination with the OSRD.

That afternoon, again in General Styer's office, Colonel Marshall received formal orders on the Army's phase of the atomic energy project. On the covering letter of the approved program, Styer wrote the following endorsement to Marshall: "This is referred to you for information and appropriate action in accordance with our discussion of this subject with Dr. Bush this morning." [2] This simple statement constituted the basic directive to the Corps of Engineers for its work on development of the atomic bomb. Styer also emphasized that the orders had come directly from the War Deparment's Services of Supply (SOS) and that Colonel Marshall would furnish all details of the new project to the Engineers chief, Maj. Gen. Eugene Reybold.

In the weeks that followed the hurried orientation of the past two days, Colonel Marshall became more familiar with the current status of the pro-

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[1] Memo, Bush to Conant, sub: Tubealloy [Tube Alloys] Prgm, 19 Jun 42, HB Files, Fldr 6, MDR.

[2] 1st Ind, Styer to Marshall, 19 Jun 42, to Ltr, Bush to Styer, same date, HB Files, Fldr 6, MDR.

BRIG. GEN. WILHELM D. STYER
(1941 photograph)

gram and what the Army's role was to be in the months ahead. He was to have broad authority to use engineer facilities, choose personnel, and take whatever steps were necessary to carry out his assignment. Marshall soon realized, however, that he was going to need all the assistance he could muster in order to have any hope of success in achieving his mission.[3]

Organizing the District

The Engineers chief normally oversaw construction projects through an engineer district, the basic unit of the engineer field organization for supervising construction work. The district engineer customarily was responsible to a division engineer, who headed one of the eleven geographical divisions in the United States (which, in 1942, constituted regional administrative headquarters of the Engineer Department of the Corps). Because of the special character, scope, and importance of Colonel Marshall's mission, however, the new district to oversee atomic energy construction would be directly subordinate to the Engineers chief and, unrestricted by geographical limitations, its field of operations would extend into other districts and divisions. Furthermore, although designated a district engineer, Marshall was to have all the authority, responsibility, and independence regularly granted to a division engineer. Indeed, in many respects, he was to have far more.[4]

While Marshall's responsibility was to the Engineers chief, in practice he worked with Reybold's assistant, Brig. Gen. Thomas M. Robins, who was in charge of construction, and particularly with his deputy, Col. Leslie R. Groves. During the summer of 1942, Robins and Groves reviewed Marshall's plans and furnished him with the support and assistance necessary to get the project started. Appropriate agencies of the chief's staff also cooperated fully with Marshall, who was able to make good use of other engineer facilities and War Department assistance. On all important de-

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[3] Marshall Diary, 19 Jun 42, OCG Files, Gen Corresp, Groves Files, Misc Recs Sec, behind Fldr 5, MDR.

[4] AR 100-20, 18 Sep 42; Paul W. Thompson, *What You Should Know About the Army Engineers* (New York: W. W. Norton and Co., 1942), pp. 194-96. Subsection based primarily on Marshall Diary, MDR, and Groves, *Now It Can Be Told*, pp. 11-18.

Brig. Gen. James C. Marshall
(1946 photograph)

cisions, Marshall consulted with Generals Reybold and Styer; the latter, in addition to his many duties as SOS chief of staff, kept well abreast of current nuclear developments. To enforce strict secrecy, Army Chief of Staff General George C. Marshall originally had forbidden Styer to reveal to the SOS commander, Lt. Gen. Brehon B. Somervell, anything about the atomic energy program. In June, however, with the entrance of the Army into an active role in the project, General Marshall directed Styer to brief Somervell and to enlist his support.[5]

In late June, Colonel Marshall opened a liaison office in Washington, D.C., in the New War Department Building at 21st Street and Virginia Avenue, NW. At the same time, he set up temporary district headquarters at 270 Broadway in New York, where he had ready access not only to the colocated administrative facilities of the Engineer Department's North Atlantic Division but also to the Manhattan office of the Stone and Webster Engineering Corporation, soon to become a major contractor for the atomic project. To staff the district, Colonel Marshall received authorization from the Engineers chief to draw on officers and civilians who had served under him in the Syracuse District, among them Lt. Col. Kenneth D. Nichols, whom he appointed assistant district engineer. The Syracuse District recently had completed the major part of its wartime construction program and, as the volume of work decreased during the summer, Marshall was able to draw more and more personnel from his former command. Soon over a dozen men had transferred to the new district. Several who were civilians at the time subsequently received reserve commissions and went on active duty. To provide still more officers, General Robins directed other districts to give Marshall a priority on any surplus personnel they might have.[6]

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[5] Styer's recollection is that he was not authorized to bring in Somervell until September, but contemporary evidence indicates Somervell was participating in late June. 1st Ind, Styer to Chief of Mil Hist, 15 Aug 61, to Ltr, Chief of Mil Hist to Styer, 17 Jul 61, CMH (cf. Marshall Diary, 26 Jun and 10 Jul 42, MDR). On the Engineers organization in early 1942 see Blanche D. Coll, Jean E. Keith, and Herbert H. Rosenthal, *The Corps of Engineers: Troops and Equipment*, U.S. Army in World War II (Washington, D.C.: Government Printing Office, 1958), pp. 132–36.

[6] Details on the engagement of Stone and Webster as a major contractor for the atomic project are

Continued

COL. KENNETH D. NICHOLS *(1945 photograph)*

Engineer districts normally took their names from the city where they were located, but Colonel Marshall's new district lacked a permanent headquarters. Some convenient designation was needed, however, that would conceal the real nature of the project. On 26 June, Generals Somervell, Styer, and Reybold agreed on the elaborate cover name of Laboratory for the Development of Substitute Materials, or DSM. Within the next two weeks Marshall's plans and organization for a new district were approved and he submitted to Colonel Groves the draft of a general order establishing a DSM District. To Groves, the term *DSM* seemed likely to arouse attention and curiosity. Accordingly, the two officers reached agreement that the name *Manhattan*, where Marshall had established his temporary headquarters, would be a better name. On 13 August, General Reybold issued a general order (effective on the sixteenth) officially establishing "a new engineer district, without territorial limits, to be known as the Manhattan District, . . . with headquarters at New York, N.Y., to supervise projects assigned to it by

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discussed later on in this chapter. Interv, Stanley L. Falk and Author with Charles Vanden Bulck (former Syracuse District civilian employee before serving as Chief, Admin Div, MD) and his assistant Capt W. R. McCauley, 22 Jun 60, CMH; MDH, Bk. 1, Vol. 1, "General," p. 3.13, DASA. See also Ltr, Marshall to Robins, 16 Nov 42, Admin Files, Gen Corresp, 231.2, MDR, in which Marshall's procurement priority was extended to supplies and equipment as well as personnel, and the word *surplus* was dropped.

the Chief of Engineers." [7] The term *DSM* continued in use as an official code name for the entire project, but the word *Manhattan*—symbolically representing the Army's contribution in the development of the atomic bomb—gradually superseded it.[8]

Meanwhile, Vannevar Bush carried out the necessary changes in the OSRD organization. Under the provisions of the newly approved program, the OSRD retained responsibility for pilot plants for the centrifuge, diffusion, and electromagnetic separation processes, as well as for further research and development on the latter method, for the heavy water project, and for additional miscellaneous research. Acting upon a suggestion of James B. Conant, based upon his review of past operating procedures of the uranium project, Bush abolished the S–1 Section and its planning board and, in their place, established the S–1 Executive Committee. Membership of the new committee included most of the individuals who had previously served in the S–1 Section: Conant, as chairman; Lyman J. Briggs; Ernest O. Lawrence; Arthur H. Compton; Harold C. Urey; and Eger V. Murphree, with the addition of Irvin Stewart, the OSRD executive secretary. H. T. Wensel, formerly of the planning board, became technical aide. Only Dean George B. Pegram of Columbia dropped out.

Bush charged the new S–1 Executive Committee with recommending contracts and supervising contract operations and enjoined its members to begin work immediately, in close coordination with the Army Corps of Engineers. Bush particularly cautioned them on the importance of maintaining the "greatest secrecy" on all phases of the project, and stated that "we will continue . . . to adhere to the principle that confidential information will be made available to an individual only insofar as it is necessary for his proper functioning in connection with his assigned duties." [9]

An additional, though temporary, responsibility of the S–1 Executive Committee was overseeing experimentation on the military applications of atomic energy. As outlined in the atomic energy program approved by the President, the Joint Committee on New Weapons and Equipment of the Joint Chiefs of Staff had primary responsibility for this administrative mission. Vannevar Bush also headed this committee. Serving with him were Brig. Gen. Raymond G. Moses, chief of the Supply Division (G–4) of the Army General Staff, and Rear Adm. Willis A. Lee, Jr., who held a similar position as Assistant Chief of Staff (Readiness), U.S. Fleet. With these officers Bush raised the question of establishing a subcommittee to consider military uses of atomic energy—formed, not hastily, but with "great care." Pending organization of this new group, Bush directed the S–1 Executive Committee to continue its work on military applications.[10]

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[7] WD, OCE, GO 33, 13 Aug 42. While the legal designation of the new district was Manhattan District, it was often referred to as the Manhattan Engineer District.

[8] Smyth *Report*, p. 59.

[9] Quoted words from Memo, Bush to Conant, 19 Jun 42, MDR. See also Stewart, *Organizing Scientific Research for War*, p. 122; Smyth *Report*, p. 59.

[10] Ltr, Bush to Styer, 19 Jun 42, and Memo, Bush to Conant, 19 Jun 42, MDR; Min, 6th Mtg of JNW, 16 Jun 42, 334, JCS; Ms, Vernon E. Davis, "Organi-

Continued

The relationship between the Manhattan District and the OSRD S-1 Committee during the summer of 1942 can best be described as a cooperative one. While each agency had its assigned functions within the overall atomic energy program, they coordinated either formally or informally on all major decisions. But they did not act together as a joint directorate, for each organization was free to proceed as it wished to carry out decisions, or other activities, strictly within its own area of competence.

Periodic meetings of the S-1 Committee with Colonel Marshall and one or more other officers of the Manhattan District provided the formal link between the two organizations. Representatives of the principal engineering or industrial firms connected with the project also attended frequently. During this period, the S-1 Committee met at least once a month, usually in executive session in the morning—while Marshall was conferring with his military superiors—and then opened the meeting to the Manhattan representatives. These joint meetings encouraged a free exchange of views, provided scientific briefings for Marshall and his colleagues, enabled the scientists to seek Army assistance where necessary, and generally enhanced coordination.[11]

Army-OSRD links were further strengthened by cooperation between Manhattan officers and civilian scientists working together on specific projects. In the beginning these ties were kept inconspicuous, especially to conceal the Army's interest. In their visits to university or industrial laboratories, Army officers usually wore civilian clothing, and every effort was made to hide the relationship between the Corps of Engineers and OSRD-directed projects. This effort was sometimes frustrated when a few scientists, unaccustomed to working under rigid security conditions, talked more freely than they should have about the Army's interest in their work. And despite Bush's warnings, even the S-1 Committee was careless on occasion. In mid-August, for example, Colonel Marshall had to point out that highly classified material should not be sent to him through the regular mail. In general, however, the good relationship between the Manhattan District and the S-1 Committee helped to keep such occurrences to a minimum.

Details of the Army-OSRD meetings reached the Top Policy Group through twin channels: scientific and military. Conant reported to Bush and Colonel Marshall to his superiors in General Reybold's office, or sometimes directly to General Styer. The latter then passed on information about the atomic project to Generals Somervell and Marshall. Secretary of War Henry L. Stimson appears to

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zational Development: Development of the JCS Committee Structure," The History of the Joint Chiefs of Staff in World War II, Vol. 2 (Washington, D.C.: Historical Division, Joint Chiefs of Staff, 1972), pp. 308-12, NARS.

[11] In addition to material from the Marshall Diary, MDR, detailed summaries of the S-1 Committee neetings are included in the DSM Chronology, DROO. The latter is a rough first-draft summary of vents relating to the Manhattan District, covering nost developments in some detail through April 943 and for the single month of July 1944, leaving gap from May 1943 through June 1944. The chronology, apparently prepared in late 1944 by Maj. Harry S. Traynor, a Manhattan staff officer, is based not only on sources cited in this volume but also on certain other materials not available to the present author.

have received only limited data on developments during the summer of 1942; Vannevar Bush submitted only one formal report to Harvey Bundy, the Secretary's special assistant for scientific affairs. To what extent Vice President Henry A. Wallace received information on atomic developments is unclear; the Top Policy Group did not meet during this period and there is no other indication that reports were sent to Wallace. Even the President's information and activities were evidently limited to the question of nuclear collaboration with Great Britain, and he seems to have discussed that only with Bush. In effect, then, the S-1 Executive Committee and Manhattan District were free to act on any mutually approved decision. Their scientific or military superiors could always exercise the right of veto, but in the summer of 1942 they apparently did not do so. Only later, when major changes were to be made in the atomic energy program, would they once more actively enter the picture.[12]

Army-OSRD Planning Meeting, 25 June 1942

On the occasion of the first meeting of the S-1 Executive Committee, convened at the Carnegie Institution in Washington, D.C., on 25 June 1942, General Styer, Colonels Marshall and Nichols, Vannevar Bush, and the regular members of the committee reached several important decisions regarding site selection, contracting with engineering firms, and obtaining government priorities for needed materials and equipment.[13]

War Department policy normally required location of new munitions plants out of range of enemy carrier-based planes, in a great inland zone between the Appalachian and Rocky Mountains and approximately 200 miles from the nation's borders with Canada and Mexico.[14] General Styer stated that the main atomic energy installations should be placed within this zone and that, to ensure secrecy, all manufacturing plants should be built at a single site. The group generally agreed with Styer on plant concentration, which would enable rapid and economical construction and facilitate control over the work. To support the extensive facilities, a continuous supply of approximately 150,000 kilowatts of electricity would be needed by the end of 1943 and hundreds of thousands of gallons of water per minute. There would have to be a climate suitable for construction in winter, a ready supply of labor, an accessibility to transportation, a relative immunity from enemy attack, and a terrain cut up by ridges that would limit the effects of any accidental explosion.

Some steps for finding a satisfactory site already had been taken. An OSRD-directed study group in early April had picked out an area near Knoxville, close to the region under intensive development by the Tennessee Valley Authority, as suitable for the full-scale centrifuge and diffusion separation plants. *(See Map 1.)* About the same time, members of Arthur Compton's team at the Metallurgical Laboratory in Chicago had been seeking a site for the full-scale plutonium production plant. They seriously weighed the possibilities of two locations near Chicago, but finally concluded that the Tennessee Valley was also the best area for their purposes. In mid-June, Bush expressed his liking for the Tennessee site to General Styer, and Colonel Marshall, in one of his first moves as district engineer, also discussed its merits with Colonel Groves. Groves made a quick survey of the electric power situation and indicated his approval of the Knoxville area. Thus, Army representatives recommended the Tennessee Valley location for all the large-scale production plants.[15]

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[12] Smyth *Report*, pp. 58–60; Stimson Diary for summer of 1942, HLS; Memo, Bush to Bundy, 29 Aug 42, HB Files, Fldr 58, MDR; 1st Ind, Styer to Chief of Mil Hist, 15 Aug 61, to Ltr, Chief of Mil Hist to Styer, 17 Jul 61, CMH.

[13] Subsection based primarily on Marshall Diary, 25 Jun 42, MDR, and DSM Chronology, 25 Jun 42, Sec. 2(e), OROO.

[14] Lenore Fine and Jesse A. Remington, *The Corps of Engineers: Construction in the United States*, U.S. Army in World War II (Washington, D.C.: Government Printing Office, 1972), pp. 134–35.

All scientific leaders at the 25 June planning meeting accepted this recommendation save Lawrence, who maintained that the electromagnetic separation plant ought to be located closer to his research operations in California. Bowing to his objections, the conferees agreed to postpone a decision on location of the electromagnetic plant, pending further progress in basic research on this process. Even though research for the centrifuge and diffusion methods was still at a stage where firm planning for production installations was impractical, the group decided that the plants for these processes as well as for the plutonium process would be located on a 200-square-mile site in the Tennessee Valley. The Army, the planning group agreed, should begin steps at once to select and acquire this site.

The planners also considered sites for two other operations. The first was a pilot plutonium plant required by the Metallurgical Laboratory. This plant needed to be within commuting distance of the laboratory; but, for reasons of safety and security, it could not be built in heavily populated Chicago. Consequently, Compton and his colleagues selected an isolated area known as the Argonne Forest, a part of the Cook County Forest Preserve about 20 miles southwest of the city. This selection was tentatively approved on 25 June and the next day Compton and Colonel Nichols reached final agreement on the general plan for the Argonne site.[16]

In 1941, the OSRD had sponsored laboratory tests at Princeton University, under the direction of British chemist Hugh S. Taylor, to develop a technique for large-scale production of heavy water by a hydrogen-water exchange process. Taylor had found that this process operated most efficiently when using the electrolytic method to produce hydrogen. The Consolidated Mining and Smelting Company, a Canadian firm, operated an ammonia plant at Trail on the Columbia River, situated a few miles

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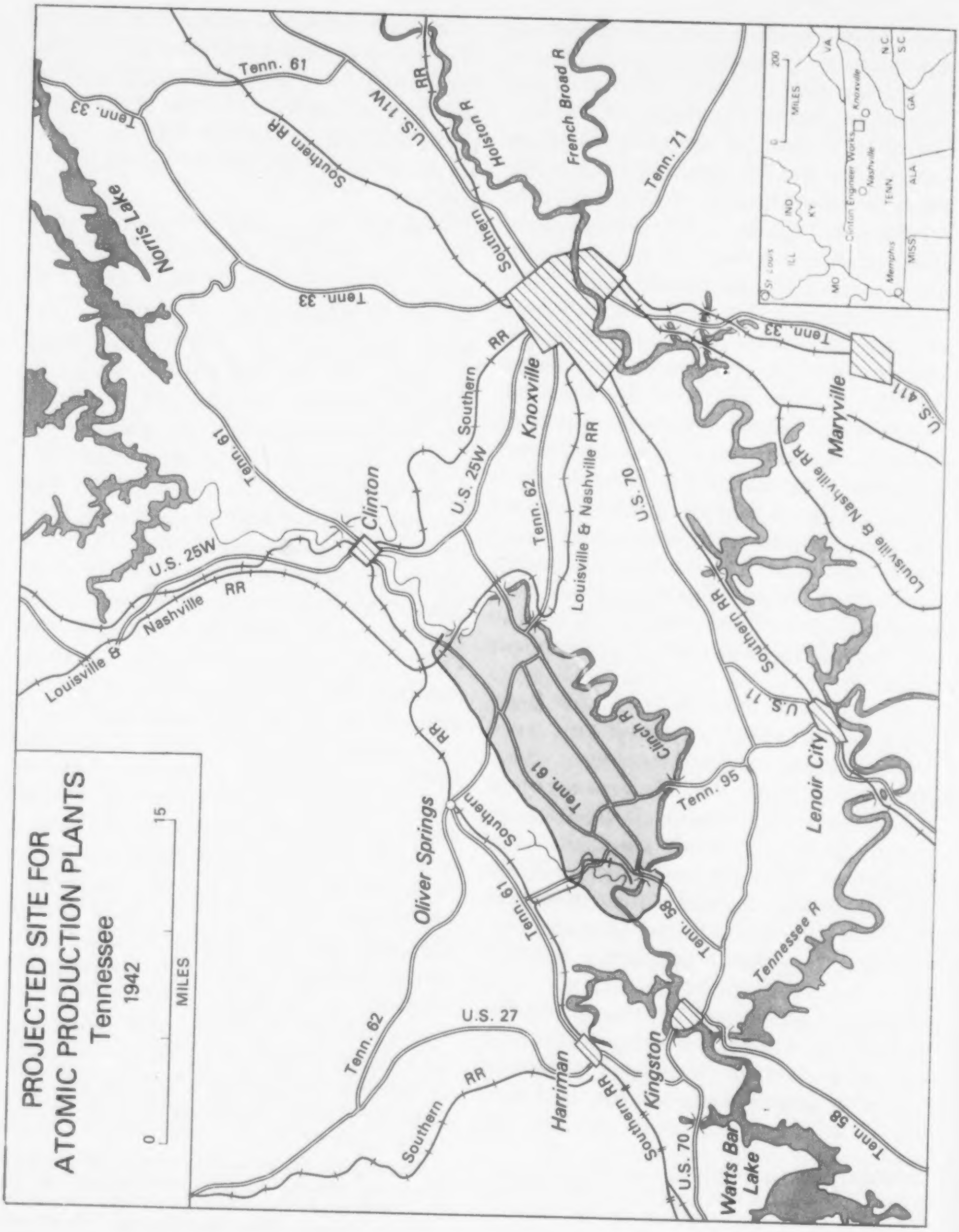
[15] MDH, Bk. 1, Vol. 12, "Clinton Engineer Works," pp. 2.1–2.6 and Apps. A140–A142, DASA; Compton, *Atomic Quest*, pp. 154–55; Ltr, Bush to Styer, 15 Jun 42, Admin Files, Gen Corresp, 600.3, MDR; Marshall Diary, 19 Jun 42, MDR; Groves, *Now It Can Be Told*, pp. 13–14.

[16] Ms, Arthur Compton, "Mr. Fermi, the Argonne Laboratory and the University of Chicago," 28 Jul 44, p. 1, Admin Files, Gen Corresp, 080 (Argonne-Univ of Chicago), MDR; Marshall Diary, 26 Jul 42, MDR; Compton, *Atomic Quest*, pp. 110–11; MDH, Bk. 1, Vol. 12, p. 2.5, DASA.



PROJECTED SITE FOR ATOMIC PRODUCTION PLANTS
Tennessee
1942

0
15
MILES
Norris Lake
Tenn. 33
Tenn. 61
Southern RR
U.S. 11W
RR
Holston R
French Broad R
Tenn. 71
Southern
Knoxville
Tenn. 33
Tenn. 61
Southern
RR
U.S. 25W
Clinton
U.S. 25W
Louisville & Nashville RR
Tenn. 62
Louisville & Nashville RR
U.S. 70
Southern RR
U.S. 11
Maryville
Louisville & Nashville RR
U.S. 411
Tenn. 33
Clinch R
Tenn. 61
Tenn. 95
RR
Southern
Oliver Springs
Tenn. 61
Tenn. 58
Lenoir City
Tennessee R
Tenn. 62
U.S. 27
Harriman
Southern RR
Kingston
RR
Southern
U.S. 70
Watts Bar Lake
Tenn. 58
St. Louis
ILL
IND
KY
VA
MO
Memphis
Nashville
Clinton Engineer Works
Knoxville
TENN
N.C.
S.C.
MISS
ALA
GA
0
200
MILES

MAP 1

north of the Canadian-U.S. border, that was the largest producer of hydrogen by the electrolytic method in North America. In an effort to tap this resource for heavy water, Taylor met with company officials to discuss the possibility of Consolidated Mining allowing its plant to be altered so that heavy water could be extracted from the hydrogen supply without using up any appreciable quantities of the hydrogen. The reaction was favorable. The OSRD therefore made the final arrangements and, in May of 1942, engaged the Boston construction firm of E. B. Badger and Sons to proceed with the engineering and design work on plant alterations. During the 25 June meeting, Army-OSRD representatives approved the plan for Trail and, on the twenty-sixth, shifted responsibility for construction to the Army but left the financing and direction of research with the OSRD.[17]

A few days before the meeting, Colonel Marshall had talked with Groves about his urgent need for competent engineering advice in organizing the atomic project and Groves had recommended Stone and Webster. The well-known Boston firm already was involved in an OSRD project on the diffusion method and was currently maintaining a good record on several contracts for the Corps of Engineers. Marshall proposed to the Army-OSRD group that it engage Stone and Webster as architect-engineer-manager for the atomic project, to monitor site development and major construction.[18]

The Army-OSRD conferees approved Marshall's proposal and agreed that Stone and Webster would be primarily concerned with site development and housing construction in Tennessee and with engineering and building the centrifuge and electromagnetic plants. In addition, the firm would build the Argonne pilot plant and, eventually, the full-scale plutonium production plant. The group also decided to engage the M. W. Kellogg Company of New Jersey. This firm had extensive experience in the design and construction of petroleum refineries and chemical installations and was already assisting the scientific team at Columbia on diffusion research under an OSRD contract. Kellogg would take responsibility for the diffusion plant and Badger and Sons would continue on the job at Trail.[19]

The Army-OSRD group decided that a substantial number of OSRD research contracts already in operation should be extended at the discretion of the S-1 Executive Committee. To continue these contracts beyond the end of the fiscal year—less than a week away—the atomic program urgently needed $15 million. Marshall promised to obtain the money immediately from engineer funds. This sum represented slightly less than half of the $31 million included for the OSRD in the program approved by President Roosevelt on 17 June. Yet it sufficed, for the Army gradually took over most OSRD functions in the field of atomic energy and the $15 million proved to be more than enough to finance all further OSRD expenditures for the atomic program.[20]

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[17] Hewlett and Anderson, *New World*, pp. 66–67; MDH, Bk. 3, "The P-9 Project," Secs. 1–2, passim, DASA; Marshall Diary, 26 Jun 42, MDR; DSM Chronology, 25 Jun 42, Sec. 2(e), OROO.

[18] Groves, *Now It Can Be Told*, pp. 12–13; Marshall Diary, 25, 27, and 29 June 42, MDR.

[19] DSM Chronology, 25 Jun 42, Sec. 2(a), OROO; Stephane Groueff, *Manhattan Project: The Untold Story of the Making of the Atomic Bomb* (Boston: Little, Brown and Co., 1967), pp. 22–23.

The final subject at the Army-OSRD meeting was the urgent need to obtain government priorities sufficiently high to ensure a ready supply of critical materials and equipment. Some required items were in extremely short supply and the OSRD was having little success obtaining them. What was needed, OSRD representatives told Colonel Marshall, was some means of coordinating their requirements and gaining the necessary priorities to satisfy them. They requested that the Army designate a priorities officer to meet with them and to establish an office in Washington, D.C. Marshall agreed and indicated that, as a first step, he would eliminate obvious competition by coordinating Army and OSRD procurement on the atomic project.

The decisions of the Army and OSRD representatives had served to inaugurate officially a new phase in the atomic energy program, a period of Army-OSRD cooperation that would last until late spring of 1943.

Progress in Research and Development

For Colonel Marshall and his Manhattan District associates, the summer of 1942 was a period of organization and planning to lay groundwork for developing an unprecedented weapon. The scope of the problem was broad. To the normal administrative headaches of setting up a very large construction and manufacturing project were added the problems of expediting and coordinating research, experimentation, industrial application, and design of a weapon based on materials that in all probability would not be available for testing until the weapon itself had been built. Of all the problems to be dealt with—the execution of engineering, construction, and operating contracts; the selection and acquisition of sites; the obtaining of large sums of money and of adequate priorities; the procurement of materials; the maintenance of security—the first and most basic to the success of the whole project was that of continued progress in scientific development. On this rested the outcome of the entire atomic enterprise. And, in mid-1942, Marshall found that nearly all problems he faced were connected in one way or another with the vital task of research and experimentation.

The program adopted on 17 June called for backing all five methods of producing fissionable materials—until one or more proved most certain of success. Thus, each process was subject to intensive research efforts that summer. Objectives for the centrifuge process were a pilot plant and, by January 1944, a full-scale plant producing 100 grams of U-235-enriched uranium per day. A low-yield pilot plant and a 1-kilogram-per-day production plant were planned for the diffusion process and a 5-gram-per-day pilot plant and, by late 1943, a 100-gram-per-day production plant for the electromagnetic process. The plutonium project needed a 100-gram-per-day production plant, as well as heavy water plants producing 0.5 tons per month by May 1943.[21] The diffusion and centrifuge methods, which had seemed most promising the previous autumn, now appeared less certain than the others. And of the pile and electromagnetic processes, the latter appeared to offer the best immediate hope.

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[20] Marshall Diary, 29-30 Jun 42, MDR; Stewart, *Organizing Scientific Research for War*, p. 123.

Although the feasibility of the gaseous diffusion method had been demonstrated, two major problems stood in the way of achieving large-scale separation of uranium isotopes. First was development of a material that would be sufficiently porous to permit passage of uranium hexafluoride through thousands of stages, as well as be resistant to the exceptional corrosiveness of this gas and suitable for fabrication by mass production methods. The second was to design and manufacture corrosion-resistant mechanical equipment—a variety of pumps, valves, seals, and instruments—to move the gas through miles of pipe, maintaining required vacuum conditions, temperatures, and pressures.

These problems were being studied mainly at Columbia University under John Dunning and Harold Urey, but also by the M. W. Kellogg Company, whose chief concern was major production of diffusion equipment and, eventually, construction of a full-scale plant. At a meeting of the OSRD S-1 Executive Committee on 30 July 1942, Urey reported his hope that the diffusion method would be producing enough enriched uranium by the fall of 1944 to begin using that material in an atomic weapon.[22]

Work on the centrifuge process was going equally slow. Under the general direction of Eger Murphree, theoretical and experimental research continued at Columbia University and the University of Virginia, respectively; design and development at the Westinghouse Research Laboratories, a subsidiary of the Westinghouse Electric and Manufacturing Company; and engineering studies at the Standard Oil Development Company. Feasibility of the method had long been demonstrated, but major technical and mechanical difficulties prevented rapid progress. Nevertheless, a pilot plant had been designed at Standard Oil and actual production of parts and models for the pilot plant was under way at Westinghouse. Like the diffusion process, the centrifuge process would require many hundreds of stages to achieve large-scale separation. Also by Murphree's estimate, the centrifuge method could not produce a sufficient amount of enriched uranium for use in atomic weapons before autumn of 1944.[23]

Of all the programs in progress that summer, perhaps the most extensive was the pile process for manufacturing plutonium under the leadership of Arthur Compton at the University of Chicago. The objectives of the Chicago program were to prove experimentally that a chain reaction was actually possible, then to devise a means to produce plutonium on a large scale and extract it chemically from uranium, to work out the necessary data for bringing about an explosive chain reaction with either plutonium or U-235, and, finally, to design the atomic bomb itself. Investigations into all of these problems were being conducted simultaneously by large research staffs at the University of Chicago and other institutions.[24] One particularly important group at the University of California (Berkeley) had been organized in June by J. Robert Oppenheimer, then widely regarded as "the leader of theoretical aspects of atomistics and similar subjects of physics." [25] Under Oppenheimer's direction a number of the nation's ablest theoretical physicists undertook a study that, in Oppenheimer's words, "for the first time really came to grips with the physical problems of atomic bombs, atomic explosions to initiate thermonuclear reactions." By the latter he meant the possibility of a hydrogen bomb, a matter that he raised with Compton and Bush that summer and that was to lie heavy on his mind for many years to come.[26]

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[21] Ltr, Bush to President, 17 Jun 42, and Incl, HB Files, Fldr 6, MDR.

[22] Smyth *Report*, pp. 125–35; MDH, Bk. 2, Vol. 3, "Design," pp. 2.1–2.2, DASA; DSM Chronology, 30 Jul 42, Sec. 2(e), OROO; Compton, *Atomic Quest*, p. 152.

[23] MDH, Bk. 1, Vol. 4, "Auxiliary Activities," pp. 14.1–14.24, DASA; DSM Chronology, 30 Jul and 26 Aug 42, each Sec. 2(e), OROO; Marshall Diary, 24–26 and 28 Aug 42, MDR.

The University of Chicago's Metallurgical Laboratory staff also devoted most of its energies to theoretical studies. Lack of basic materials—uranium, plutonium, highly purified graphite, and heavy water—made any extensive experimentation program impossible. Nevertheless, at the 30 July meeting of the S-1 Committee, Compton estimated that plutonium would be ready for use in an atomic weapon by fall of 1944.[27] The process that appeared to offer the best hope for producing fissionable materials was the electromagnetic method under study at Princeton and at the University of California (Berkeley), where Lawrence's work with the giant 184-inch magnet attracted the most attention. As with other approaches, this method had been faced with major technical difficulties, but as the months passed Lawrence enthusiastically reported success in meeting and overcoming these problems. Most important, he had actually achieved the separation of small amounts of U-235, even though only in milligram quantities.[28]

A visit in late July to Berkeley by Colonel Marshall and Stone and Webster representatives convinced them that, in Marshall's words, "Lawrence's method is ahead of the other[s] . . . and should be exploited to the fullest without delay." The colonel was anxious that work on "a sizeable pilot plant," as well as a full-scale production plant, begin as soon as possible.[29] The S-1 Committee approved Colonel Marshall's recommendation on 30 July and decided that the Army, rather than the OSRD, would be responsible for building the pilot plant on land rented from the University of California. Lawrence estimated that material from the electromagnetic process would be ready to go into an atomic weapon by the spring of 1944.

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[24] Account of work carried out at Chicago based on Compton's book *Atomic Quest*, pp. 80–98; Smyth *Report*, pp. 63–74; Testimony of Oppenheimer in Atomic Energy Commission, *In the Matter of J. Robert Oppenheimer: Transcript of Hearing Before Personnel Security Board* (Washington, D.C.: Government Printing Office, 1954), pp. 11–12 and 27–28.

[25] Testimony of Bush in *Oppenheimer Hearing*, p. 563.

[26] Quotation from Ltr, Oppenheimer to Nichols, 4 Mar 54, *Oppenheimer Hearing*, p. 11. See also Memo, Bush to Bundy, 29 Aug 42, HB Files, Fldr 58, MDR.

[27] Smyth *Report*, p. 67; DSM Chronology, 30 Jul 42, Sec. 2(e) OROO.

[28] Discussion of electromagnetic process based on Marshall Diary, 9, 20, 30–31 Jul and 5, 17–19, 22 Aug 42, MDR; Smyth *Report*, pp. 136–41 and 143–45; DSM Chronology, 9 and 30 Jul 42, each Sec. 2(e), OROO.

[29] Marshall Diary, 20 Jul 42, MDR.

In mid-August, Colonel Nichols visited Berkeley and gave his tentative approval to plans for the pilot plant. With him was Maj. Thomas T. Crenshaw, whose job it was to set up the new California Area Engineers Office of the Manhattan District, to support and assist Lawrence, and to represent Colonel Marshall during construction and operation of the pilot plant. Nichols felt that Lawrence was "making great progress and that the whole project should be pushed into full-scale production as fast as possible," an opinion with which Lawrence agreed wholeheartedly. Indeed, because Lawrence's only question concerned the actual efficiency of the separation units, he felt that construction of the full-scale production plant should be started concurrently with that of the pilot installation.[30]

At the 26 August meeting of the S-1 Committee, both August C. Klein, Stone and Webster's chief mechanical engineer, and Colonel Marshall supported Lawrence's proposal, and there was general agreement, based upon Lawrence's optimistic report, that the electromagnetic method would probably be first to yield material in substantial amounts. The plutonium process, though progressing satisfactorily, was still months away from even the pilot plant stage and the other methods lagged even further behind. Had a decision been made at this time to back a single horse in the nuclear race and to scratch the others, Lawrence very likely would have been the one rider left on the course.

Yet no one was certain that the electromagnetic method would prove to be the best process in the long run. In fact, the group conjectured that the ultimate full-scale plant would probably have several times the capacity of the contemplated electromagnetic production plant and was likely to be comprised of a combination of methods, with one process producing enriched uranium and the electromagnetic method providing the final stage of separation. They thought a decision to proceed with an electromagnetic production plant was unrealistic and might be interpreted as a final decision in favor of the electromagnetic process, causing the development of the other methods to be slowed down—or even eliminated.

At last the conferees at the 26 August meeting agreed to continue work as rapidly as possible on the four pilot plants and on the production of heavy water at Trail. A start on a full-scale plutonium production plant would be delayed, pending the outcome of experiments at the Argonne pilot plant. Design and construction of an electromagnetic production plant would be postponed until mid-September, when the S-1 Committee was to visit the Berkeley project and make further recommendations. Vannevar Bush approved these conclusions and passed them on to Secretary Stimson with the warning that the time would soon be at hand for a major decision on the extent of the effort the United States should make on the atomic energy program.[31]

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[30] Quotation from Marshall Diary, 17–18 Aug 42, MDR. See also Memo, Crenshaw to Dist Engr, sub: Weekly Progress Rpt, 22 Aug 42, Admin Files, Gen Corresp, 001 (Mtgs), MDR.

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[31] Marshall Diary, 26 Aug 42, MDR; DSM Chronology, 26 Aug 42, Sec. 2(e), OROO; Memo, Bush to Bundy, 29 Aug 42, HB Files, Fldr 58, MDR.

CHAPTER III

First Steps for Weapon Development

In those incredibly busy two months following the planning meeting of 25 June 1942, the military leaders—working closely with project scientists and technicians—energetically set about not only to organize the operational requirements for the Army's administration of the project but also to carry out the specific steps for development of an atomic weapon. On the twenty-sixth Maj. Gen. Eugene Reybold, chief of the Corps of Engineers, held a briefing with Brig. Gen. Thomas M. Robins, the assistant chief; Col. Leslie R. Groves, the deputy assistant; Col. James C. Marshall, the new district engineer; and Lt. Col. Kenneth D. Nichols, the deputy district engineer. During the session Reybold reviewed some of the immediate problems of the atomic project, placing special emphasis on two that required prompt action: selection and acquisition of a site for atomic production facilities in the Tennessee Valley, and securing a contract with the Stone and Webster Engineering Corporation to serve as architect-engineer-manager (AEM).

Securing an Architect-Engineer-Manager

Consistent with Army policy that the industrial operator of a proposed installation should have a strong voice in selection of the specific site, the district engineer gave his first attention to securing a working agreement with Stone and Webster, which was slated to have the chief responsibility for the Tennessee plants.[1] Following Colonel Marshall's orders, Colonel Nichols went to New York on Saturday, 27 June, to visit Stone and Webster President John R. Lotz. Nichols outlined the role projected for the firm and Lotz responded enthusiastically. The following Monday, Lotz and other company officials met with Robins, Groves, Marshall, and Nichols in Washington, D.C. Lotz assured them the AEM job would not seriously interfere with the firm's work on other important Corps of Engineers contracts and that the firm could meet the strict security requirements of the atomic project. The group then drew up a letter of intent, which Lotz and Marshall signed, authorizing Stone and Webster to begin work immediately on preliminary investigations and surveys, procurement of supplies, and initiation of design. The following afternoon, Vannevar Bush, director of the Office of Scientific Research and Development (OSRD), gave the Stone and Webster representatives a thorough explanation of the technical processes involved in the atomic project. This completed the preliminary discussions.

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[1] Marshall Diary, 26 Jun 42, OCG Files, Gen Corresp, Groves Files, Misc Recs Sec, behind Fldr 5, MDR; Fine and Remington, *Corps of Engineers: Construction*, p. 135.

Stone and Webster now became the Army's agent for managing the atomic energy project, charged with overseeing and subcontracting all research and development, procurement, engineering, and construction that fell within the Army's sphere of responsibility. Company officials established a separate engineering group to operate with the utmost secrecy under the direct control of the firm's senior engineers. Project leaders had hoped that a single company could perform all AEM tasks; however, by the time Stone and Webster signed the formal contract (backdated to 29 June) several months later, the Army had to seek the assistance of other major firms to share with Stone and Webster the vast and complex job.[2]

Obtaining Funds

The Stone and Webster agreement required immediate funds. The approved program had allotted $85 million—$54 million for the Army Corps of Engineers and $31 million for the OSRD—but had not indicated the source of this money.[3] An effort in early June to obtain this sum from the President's Emergency Fund was unsuccessful. Marshall's pressing financial obligations totaled $38 million: $10 million to cover the letter of intent issued to Stone and Webster, $15 million to repay the sum advanced to the OSRD, $6 million for site acquisition, $2 million for the projected Argonne pilot plant, and $5 million for the purchase of materials. He also required "practically unlimited authority," as he put it, to spend it.[4]

By 16 July, Marshall was able to arrange for an allotment from the Office of the Chief of Engineers, specifically from the Engineer Service–Army category of available funds. The $15 million for the OSRD had already been provided, $5 million was furnished immediately, and the remainder became available a few weeks later at the time of the formal allocation of the total sum. Marshall also received assurances from the War Department's budget officer that all restrictions on the use of these funds that could legally be removed had been set aside. These included regulations on establishing title to property, the placing of government contracts, employment in the United States and abroad, rentals and improvements of property, and several other controls. Colonel Marshall appeared to be well on the way to attaining the fiscal means and independence that the atomic project required.

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[2] Marshall Diary, 27, 29–30 Jun and 1 Jul–23 Oct 42, MDR; Completion Rpt, Stone and Webster, sub: Clinton Engr Works, Contract W–7401–eng–13, 1946, pp. 6 and 143, OROO; Stone and Webster, *A Report to the People: Stone and Webster Engineering Corporation in World War II* ([Boston]: Stone and Webster, 1946), pp. 9–13; Smyth *Report*, p. 28.

[3] Ltr, Bush to President, 17 Jun 42, and Incl, HB Files, Fldr 6, MDR.

[4] Marshall Diary, 10 Jul 42, MDR. Section on funds based on entries in ibid. for 29–30 Jun, 9–11 and 16 Jul 42; Memo, Marshall to Groves, sub: Allotment of Additional Funds to MD, 29 Sep 42, Admin Files, Gen Corresp, 110 (Appropriations), MDR; Groves, *Now It Can Be Told*, pp. 15–16.

Securing a Priority Rating

Even as fiscal problems eased, the atomic project encountered serious difficulties on the matter of priorities. In the summer of 1942, competition for critical materials was strong and unremitting as America prepared to halt the worldwide Axis offensive. With these conditions prevailing, Colonel Marshall soon realized that access to the scarce supplies and equipment needed for atomic research, construction, and production might be blocked unless he could secure a high-priority rating for the project.

In the wartime economy, the establishment of priorities for military and civilian demands was the responsibility of the War Production Board (WPB), succinctly characterized by one World War II historian as "the supreme industrial mobilization control agency." [5] The Army and Navy Munitions Board (ANMB) administered the priority system for military and related agencies, theoretically subject to WPB approval, but in 1942 the War Department's Services of Supply (SOS) gradually began to take over the ANMB's responsibilities relating to the Army. The SOS, particularly through its staff divisions for requirements and resources that formed the ANMB's Army Section, controlled and coordinated all War Department procurement activities. SOS officers, moreover, served on WPB committees. For example, Brig. Gen. Lucius D. Clay, the SOS deputy chief of staff for requirements and resources, had an important voice in the establishment of policy and would play a key role in the matter of assigning priorities to the atomic project.

Major programs received ratings of AA-1 through AA-4, in decreasing order of precedence, whereas lesser projects received ratings in a more extensive category, the highest designation of which was A-1-a. A special top rating of AAA, reserved for emergencies, could not be assigned to an entire program but was limited to expediting delivery of small quantities of critical items. Although the program approved by President Roosevelt did not mention a specific priority designation for the new project, it did imply that the program should be given a relatively high rating, which was to be balanced against the needs of other critical projects.[6] When Colonels Marshall and Nichols met with General Clay on 30 June, they requested only an AA rating—without, apparently, asking for a specific classification within that category. Marshall assured Clay that the project "would issue such lower ratings as were possible whenever we did not need the A." [7] General Clay, who had known Marshall since their days as West Point classmates, told Marshall and Nichols that all DSM requests would be given prompt attention and the highest preference in processing, and that he personally would take immediate steps to obtain an AA rating for the project and would be available at any time for any specific request.

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[5] R. Elberton Smith, *The Army and Economic Mobilization*, U.S. Army in World War II (Washington, D.C.: Government Printing Office, 1959), p. 517. Discussion of DSM priority problems based primarily on Marshall Diary, 25 Jun–16 Sep 42, MDR; DSM Chronology, Jun–Sep 42, Sec. 18, OROO; Memo, Bush to Bundy, 29 Aug 42, HB Files, Fldr 58, MDR; Groves, *Now It Can Be Told*, pp. 16 and 22–23.

[6] Ltr, Bush to President, 17 Jun 42, and Incl, MDR.

[7] Marshall Diary, 30 Jun 42, MDR.

Despite Clay's assurances, nearly two weeks passed with no priority rating forthcoming. Finally, on 13 July, following some persistent prodding by Colonel Nichols, the ANMB approved a rating of AA-3 for the atomic project.[8] This rating, with which Clay concurred, came as a grave disappointment. It was based, however, on an ANMB directive that limited AA-1 and AA-2 ratings to the most essential and urgently needed weapons and equipment—airplanes, ships, guns, and tanks scheduled for production in 1942. Even AA-3 ratings were reserved for those items of military equipment and construction that constituted an essential part of the 1942 program or were required in 1942 for the 1943 program. Under the circumstances, a rating of AA-3 was the highest the atomic project could have received. Indeed, given the as yet unproved nature of the project, the cautious estimates of how long it might take to produce atomic weapons, and the absence of a specific presidential directive assigning it a high priority, the wonder is that the atomic program fared as well as it did. Because the ANMB was limiting AA-1 and AA-2 ratings, Clay told the protesting Nichols that an AA-3 should be adequate for the atomic project. If difficulties did arise, he promised the project could obtain an AAA priority to pry loose certain critical items. With this assurance, the atomic project leaders had to be satisfied.

The anticipated problems were not long in appearing. Badger and Sons soon reported that the heavy water reconversion work on the Trail plant was coming into competition with its commitments in the synthetic rubber program. Both projects had an AA-3 rating, with the rubber program having first choice on materials and skilled workmen because of its earlier start. By mid-August 1942, Badger officials estimated the Trail plant would probably not go into operation until August 1943, although an AA-1 rating might better this date by at least two or three months. This, however, would cause a delay in the rubber program and, as S-1 Committee Chairman James B. Conant pointed out to Colonel Nichols, it would be bad politics to push for a higher priority at Trail at the expense of such a critical project as synthetic rubber. As a matter of fact, General Clay had already indicated his opposition to such a move. Thus, for the moment, the best policy seemed to be to go ahead at Trail under the AA-3 rating.

Procurement was generally an S-1 Executive Committee responsibility, and only when the OSRD was unable to secure the necessary priorities did it turn to the Army for help. During

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[8] Written confirmation came ten days later. 1st Ind, Col Joseph L. Phillips (Priorities Br chief, Resources Div, SOS) to Chief of Engrs, 23 Jul 42, to Ltr, Nichols to Priorities Div, ANMB, Attn: Col Phillips, sub: Preference Rating [for] DSM Proj, 23 Jul 42, in MDH, Bk. 1, Vol. 9, "Priorities Program," App. A3, DASA.

July, difficulties in obtaining small but essential quantities of scarce materials held back progress on important experimental work. Two much-needed nickel shipments totaling less than 85 pounds, for example, were threatened with a delay of several months and were only cleared for delivery after two weeks of effort by OSRD members, General Clay, and Maj. Gen. Wilhelm D. Styer, the SOS chief of staff.[9]

On 30 July, the S–1 Committee raised this problem with Colonels Marshall and Nichols, and the group decided to urge OSRD Director Vannevar Bush to ask WPB Chairman Donald Nelson for a blanket AA–1 priority for all atomic project orders below a value of $1,500 or $2,000, to eliminate bottlenecks without interfering unduly with other wartime programs. The next day Marshall, accompanied by Nichols, went again to see General Clay, making one last attempt to secure the desired rating before going over his head. Clay repeated that the atomic project was entitled to no higher rating than AA–3, except in very few specific instances, and said he would oppose any effort to secure a blanket AA–1 rating. That afternoon, Marshall, Nichols, Conant, and others met with Bush, emerging with an agreement that the OSRD director would confer with the WPB chairman. Receptive to Bush's proposal, Nelson promised to discuss the matter further with Army Chief of Staff General George C. Marshall, but whether or not he actually did is unclear. In the end, the matter was referred back to the ANMB, which still refused to grant a higher rating but worked out a procedure that eliminated the bottleneck on small orders.

Meanwhile, the priorities situation worsened. Securing materials became progressively more difficult. Steel, for example, would soon be virtually unobtainable with less than an AA–2 rating. Without access to this basic material, the atomic project would come to a standstill. Marshall was already receiving reports of delays in plant construction and, in mid-August, the ANMB questioned continued assignment of even an AA–3 priority to the Trail project. Prompt action by General Clay ended that threat, however.

On 26 August, Marshall, Nichols, and Stone and Webster representatives met with the S–1 Executive Committee, and again priorities were a major topic. Most small orders were now being handled without undue delay, but there was serious general concern about the large-scale procurement soon to be required for the production plants. A limited number of firms had the organization and experience needed to build and operate the major facilities, and they were all heavily engaged on other AA–3 programs for which orders had been placed before atomic project orders. The only way to push ahead of other programs was to get a higher priority. With an AA–1 priority, the electromagnetic separation pilot plant would probably be ready by April instead of August 1943 and earlier completion dates for other plants would also be assured. The effect of achieving this end, however, would be that of delaying the progress of other vital projects. Clearly a decision was needed, perhaps from the President himself, on the relative importance of the atomic project and other war programs. Either atomic energy should be pushed with a higher priority, or it should remain an experimental project for postwar application, with a lower priority.

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[9] Correspondence relating to this incident, beginning with Ltr, Styer to Dr. H. T. Wensel (Natl Bur of Standards), 26 Jun 42, filed in AG 313.3 (22 Aug 47).

As a result of these conclusions, on 29 August Colonel Nichols again called on General Clay. With concurrence from General Styer, Nichols now outlined the status of the atomic energy program and presented the unanimous opinion of its Army and OSRD leaders that a higher priority was necessary. If Clay would indicate exactly what procedure must be taken to secure an AA-1 priority from the ANMB and WPB, Bush would obtain a letter signed by the President and addressed to whomever Clay thought necessary. Clay suggested that a letter go from the Joint Chiefs of Staff to the ANMB and that it simply state that the atomic project should be granted a higher priority. But he himself opposed this course. He did not believe that the presidential approval of 17 June ever implied the granting of an overall AA-1 rating and he was convinced that the project was less important than "tanks and other munitions of war." Clay would support the AA-3 priority, but nothing higher. In Nichols's presence, he telephoned Brig. Gen. Theron D. Weaver—director of the SOS Resources Division and, thus, the ANMB's senior Army representative—and directed that the AA-3 rating assigned to the atomic project should not be questioned.[10]

On the same day, Vannevar Bush wrote to Harvey Bundy, Stimson's special assistant who served as the Secretary's personal agent in scientific affairs. Bush knew that his memorandum would come to Stimson's attention. He summarized the current status of the atomic energy project and its plans and hopes for the future in relation to the problem of priorities. He emphasized that if the ANMB persisted in its view that Manhattan did not need a higher priority rating, the entire atomic bomb program would be delayed. The time had come, he continued, for weighing the relative importance of the atomic program against other wartime programs with which it might interfere and, on that basis, deciding the best way to expedite its development. "From my own point of view," he concluded, "faced as I am with the unanimous opinion of a group of men that I consider to be among the greatest scientists in the world, joined by highly competent engineers, I am prepared to recommend that nothing should stand in the way of putting this whole affair through to conclusion, on a reasonable scale, but at the maximum speed possible, even if it does cause moderate interference with other war efforts."[11]

Bundy showed Bush's memorandum to the Secretary a few days later, but there is no indication that Stimson took any immediate action.[12] Meanwhile, Stone and Webster representatives reported that steel companies had reacted negatively to their attempts to place orders and the ANMB warned Manhattan officers that the rating was scarcely sufficient to secure the steel needed for the projected electromagnetic pilot plant.

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[10] Marshall Diary, 29 Aug 42, MDR. Quoted phrase in Nichols's recollection, recorded in the diary, of what Clay told him.

[11] Memo, Bush to Bundy, 29 Aug 42, MDR. On Harvey Bundy's position in Stimson's office see Henry L. Stimson and McGeorge Bundy, *On Active Service in Peace and War* (New York: Harper and Brothers, 1947), pp. 343-44. Harvey Bundy, a Boston lawyer, served as Assistant Secretary of State under Stimson, from 1929 to 1933.

Stone and Webster experienced a similar response to its efforts to obtain copper required for the Trail project. Capt. Allan C. Johnson, assigned in August to head the project's liaison office in Washington, D.C., found that WPB and ANMB officials viewed the AA–3 rating as indicating that the atomic bomb program was, as he phrased it, "an unimportant miscellaneous type."[13] On 12 September, Marshall asked the ANMB for an AAA rating for the Trail copper. Three days later, backed by Colonel Groves, the district engineer went to see General Weaver of the ANMB and the following day the board assigned the rating, but only with the understanding that the metal would be drawn from the normal quota of the Corps of Engineers. Unfortunately this delayed other engineer projects, but Marshall had no alternative. His action opened the way for the work at Trail to proceed on schedule.

Despite the victory on copper procurement for Trail, there was universal agreement among those concerned with the atomic energy program that improvement in the whole priorities picture was an absolute necessity if the entire project was not to founder. Groves felt that DSM leaders would be able to justify a higher priority rating only after sites were definitely selected, plans were firmly adopted, and actual construction was under way. He urged Marshall to move ahead on these matters with all possible speed. As chairman of the S–1 Executive Committee, Conant had concluded that nuclear developments had become more important than the highly rated synthetic rubber program and now believed that they should be given preference. Bush, too, saw the immediate need and called for assignment of a higher priority. The problem in mid-September 1942, as Groves later recalled it, was "quite simple." If atomic energy "was really the most urgent project, it should have the top priority."[14] The solution to this problem was not far off, but it would not come before the atomic project itself had undergone major organizational changes.

Procuring Essential Materials

Certain materials essential to the program had never been in sufficient demand for industrial or commercial use to have been produced in quantities. At the time the Army entered the atomic project, three such materials were urgently required: processed uranium feed material (chemical compounds and metal), highly purified graphite, and heavy water. The Manhattan District had to develop its own sources of supply for these essential materials.

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[12] Stimson Diary, 1 Sep 42, HLS.

[13] Marshall Diary, 2 Sep 42, MDR.

[14] Groves, *Now It Can Be Told*, p. 22.

Uranium

In early 1942, the OSRD S-1 Section's planning board had located sufficient raw uranium ore in North America to satisfy the anticipated requirements of the project for many months to come. But the means for converting this uranium into the various kinds of feed materials needed for the different methods of producing fissionable materials were almost wholly lacking. While the OSRD had taken some steps to secure these materials, the major task of procurement remained to be carried out by the Army.

The most immediate demand was for processed uranium in the form of metal for the Metallurgical Laboratory. Raw uranium ore is customarily refined either as uranium oxide, commonly termed black oxide, or as uranium salts. The oxide or the salts can be converted into metal by additional processing; however, at the beginning of 1942, this was still complicated and expensive and only a limited quantity was available in the United States—several grams of good quality produced experimentally by the Westinghouse Electric and Manufacturing Company and a few pounds in the form of pyrophoric powder manufactured by Metal Hydrides, Inc., of Beverly, Massachusetts. Both Westinghouse and Metal Hydrides had obtained the black oxide from the Canadian Radium and Uranium Corporation of New York.

Canadian Radium's source was the mine owned by Eldorado Gold Mines, Ltd., at Great Bear Lake in Northwest Canada (*Map 2*). Eldorado processed the ore in its refinery at Port Hope, Ontario, and then marketed it in the United States through Canadian Radium. The mine itself had been closed and allowed to fill with water in the summer of 1940, because sufficient ore had been stockpiled to satisfy anticipated demand for five years. The uranium for early atomic research in the United States had come from these stockpiles. When the OSRD placed a sizable order in 1941, it obtained additional equipment and supplies for getting the mine back into operation and, meanwhile, Canadian Radium continued to supply amounts of black oxide refined from the stockpiled ores.[15]

As deliveries increased during the spring of 1942, project scientists intensified their efforts to develop better methods of purifying the material and transforming it into metal. Experiments at the National Bureau of Standards demonstrated that an ether process, long known, could remove all impurities by a single extraction method, greatly simplifying the conversion of black oxide into uranium dioxide, or brown oxide, the starting point for uranium metal production. Arthur Compton arranged with Edward Mallinckrodt, an old friend who owned the Mallinckrodt Chemical Works in St. Louis, to develop large-scale production of brown oxide, using the ether process. To ensure an adequate supply of uranium oxide, Colonel Nichols directed Stone and Webster to buy 350 tons from Canadian Radium to cover the project's needs for the year ahead.[16]

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[15] Smyth *Report*, pp. 65–66; Hewlett and Anderson, *New World*, p. 65; MDH, Bk. 7, Vol. 1, "Feed Materials and Special Procurement," p. 3.1, DASA.

[16] MDH, Bk. 7, Vol. 1, App. F2, DASA; Marshall Diary, 7 Jul 42; MDR; DSM Chronology, 7 Jul 42,

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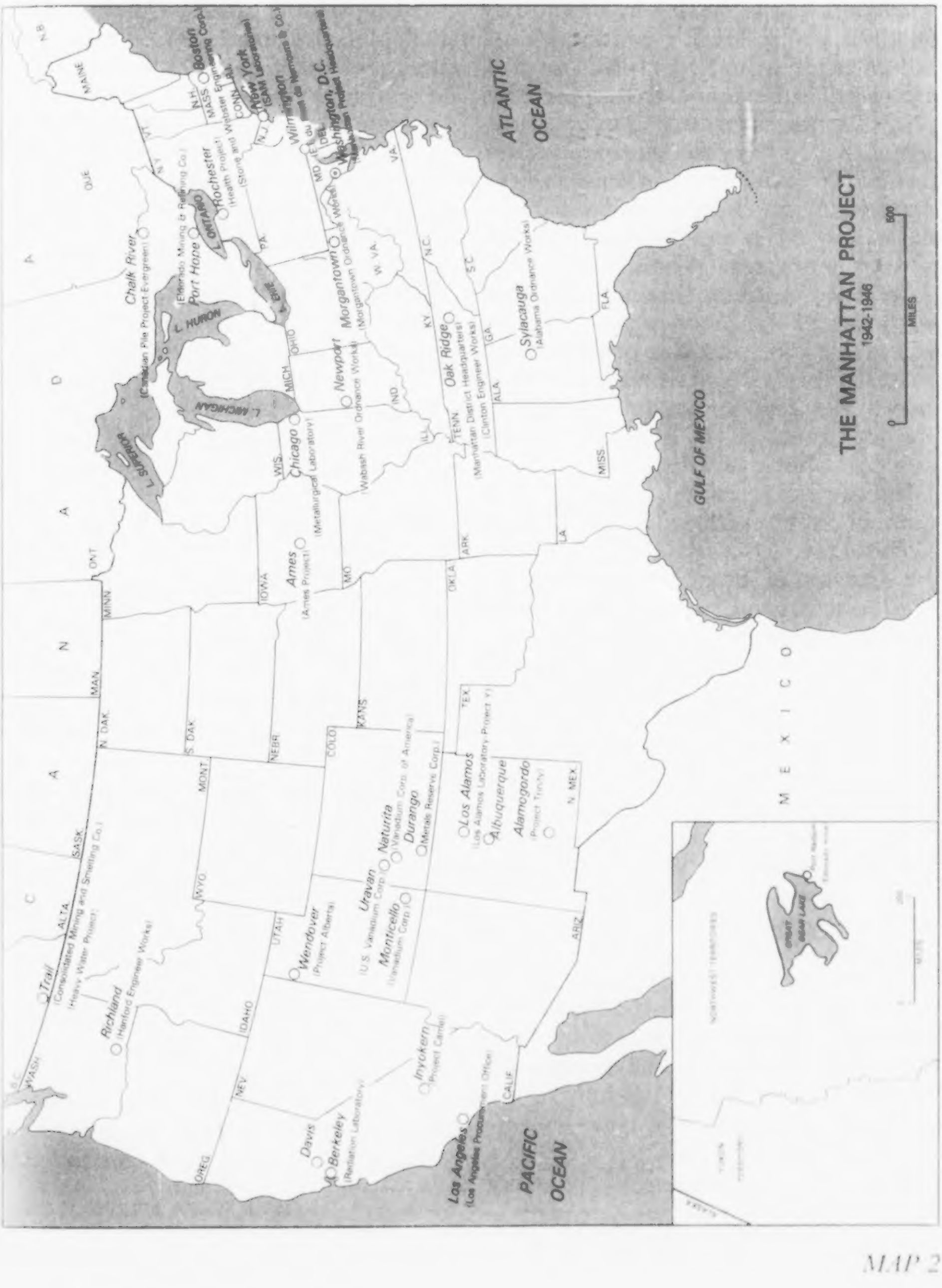
THE MANHATTAN PROJECT
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L. HURON
L. ERIE
L. ONTARIO
Trail (Consolidated Mining and Smelting Co.) (Heavy Water Project)
Richland (Hanford Engineer Works)
Davis
Berkeley (Radiation Laboratory)
Los Angeles (Los Angeles Procurement Office)
Inyokern (Project Camel)
Wendover (Project Alberta)
Uravan (U.S. Vanadium Corp.)
Monticello (Vanadium Corp.)
Naturita (Vanadium Corp. of America)
Durango (Metals Reserve Corp.)
Los Alamos (Los Alamos Laboratory Project Y)
Albuquerque
Alamogordo (Project Trinity)
Ames (Ames Project)
Chicago (Metallurgical Laboratory)
Newport (Wabash River Ordnance Works)
Oak Ridge (Manhattan District Headquarters) (Clinton Engineer Works)
Sylacauga (Alabama Ordnance Works)
Morgantown (Morgantown Ordnance Works)
Chalk River (Canadian Pile Project Evergreen)
Port Hope (Eldorado Mining & Refining Co.)
Rochester (Health Project) (Stone and Webster Engineering)
Boston (Stone and Webster Engineering Corp.)
New York (SAM Laboratories)
Wilmington (E.I. du Pont de Nemours & Co.)
Washington, D.C. (Manhattan Project Headquarters)
B.C.
ALTA.
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CONN.
R.I.
MASS.
VT.
N.H.
MAINE
NORTHWEST TERRITORIES
YUKON
ALASKA
GREAT BEAR LAKE
Port Radium

MAP 2

Thanks to these measures, by the fall of 1942 Mallinckrodt's production of brown oxide from Eldorado's ore had increased sufficiently to supply the project's requirements. Mallinckrodt and other chemical firms converted the brown oxide into uranium tetrafluoride, or green salt, the feed material employed in most uranium metal-making processes. Westinghouse had abandoned a photochemical method in favor of a faster process using green salt and soon was producing at a satisfactory rate. At first Metal Hydrides was less successful, failing to provide a metal of sufficient purity with pyrophoric powder.

Intensive research during the summer at Massachusetts Institute of Technology, Iowa State College, and the Bureau of Standards had developed new and improved metal-making techniques. Most important was a steel-bomb process for reducing green salt to metal, employing highly purified calcium—and later magnesium—as a reduction agent. By early 1943, using this method, Iowa State had developed a manufacturing program and Metal Hydrides had significantly increased its output. New Army contracts with the Electro Metallurgical Company of Niagara Falls, New York, a subsidiary of Union Carbide and Carbon Corporation, and with E. I. du Pont de Nemours and Company further increased production, and the acute metal shortage was largely relieved by 1944.[17]

In September 1942, Colonel Marshall placed Capt. John R. Ruhoff in charge of all uranium metal production. Ruhoff had been a chemical engineer at Mallinckrodt, assisting in the uranium oxide program, and when he was inducted into the Army that summer, Manhattan officials had arranged his assignment to the District as its area engineer in St. Louis, with headquarters at the Mallinckrodt firm. Then in October, Marshall formed a Materials Section in the District office to administer the whole feed materials program. He selected Lt. Col. Thomas T. Crenshaw of the California Area Engineers Office to head the section and had Ruhoff transferred to New York to serve as Crenshaw's assistant.[18]

Meanwhile, project leaders knew the reopened Eldorado mine would probably not be able to produce and ship ore for at least another year and that stockpiles at the Port Hope refinery were insufficient for the 350 tons of oxide ordered for the project in July. They urgently needed a source that could provide high-grade uranium on short notice. Such a source, in fact, had long been close at hand. Late in 1940, when German seizure of much of Africa appeared likely, Edgar Sengier—head of Union Miniere with whom Alexander Sachs of Wall Street and Harold Urey of Columbia had earlier conferred—had ordered shipment of approximately 1,200 tons of high-grade ore from the Shinkolobwe stockpile in the Congo via Portuguese West Africa to New York. Storing the

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Sec. 20, OROO; Memo, [Ruhoff] to Groves, sub: Summary of Ore Contracts, 15 Feb 44, Admin Files, Gen Corresp, 161 (African Metals), MDR; Compton, *Atomic Quest*, pp. 93–95.

[17] MDH, Bk. 7, Vol. 1, pp. 10.1–10.9, DASA; Hewlett and Anderson, *New World*, pp. 87–88 and 293–94; Memo, Nichols to Groves, 21 Dec 44, Admin Files, Gen Corresp, 319.1, MDR; DSM Chronology, 4 Sep 42, Sec. 20, OROO.

[18] MDH, Bk. 7, Vol. 1, pp. 1.16–1.17, DASA; Compton, *Atomic Quest*, pp. 95–96.

ore in a warehouse in Port Richmond on Staten Island, Sengier apparently made no effort to call it to the attention of American government officials until after the United States entered the war. Attending a meeting in Washington, D.C., in March 1942, he mentioned his Staten Island cache to Thomas K. Finletter and Herbert Feis, State Department officials concerned with international economic affairs, but neither state nor defense officials indicated any immediate interest in the ore—why is not entirely clear. Nevertheless, it was soon common knowledge in trade circles that Sengier was interested in selling the ore.[19]

It was early September 1942, however, before word of the Congo ore reached Manhattan District officials. The Standard Oil Development Company, working on the centrifuge process, had opened negotiations with Sengier for procurement of the uranium oxide it needed. Through Standard Oil, Metallurgical Laboratory staff members learned of the Staten Island ore and sought to purchase additional quantities. Through his Union Miniere outlet in New York, the African Metals Corporation, Sengier had submitted a request to the State Department for a license to ship ore from Port Richmond to Eldorado's refinery in Ontario, for processing into black oxide. On 7 September, Colonel Nichols received a query from Finletter concerning the request from African Metals—his first inkling of the existence of the Congo ore. Nichols acted promptly; he met with Finletter and Feis at the State Department on 12 September and then dispatched Captain Ruhoff to consult with Stone and Webster in Boston and Sengier in New York, while he himself hurried to California for the meeting of the OSRD S-1 Executive Committee on the thirteenth and fourteenth. The committee recommended that all Sengier's ore be acquired.[20] Thus, at just the time when an acute shortage of uranium threatened to seriously delay the atomic project, the store of rich Congo ore became available to provide most of its wartime requirements.

Graphite, Heavy Water, and Silver

Either highly purified graphite or heavy water to use as a moderator in the atomic pile was essential for the plutonium program and the other work under way at the Metallurgical Laboratory. Ample graphite was already being produced commercially in the United States; the question was one of "purity and priority." The main quality required in the graphite was low-neutron absorption, which was directly dependent on its purity. Unfortunately, the standard product had too many impurities, particularly boron. Scientists at the National Bureau of Standards traced the boron in commercial graphite to the coke used for its production. By substituting petroleum for coke and altering certain manufacturing techniques, both National Carbon Company and Speer Carbon Company were soon producing highly purified graphite that absorbed 20 percent fewer neutrons and satisfied the stringent requirements of the Metallurgical Laboratory. With the WPB's cooperation in arranging the necessary priorities, the OSRD was able to place large orders with these firms, essentially solving the atomic energy program's graphite problem.[21]

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[19] Groves, *Now It Can Be Told*, pp. 33-35; Hewlett and Anderson, *New World*, pp. 85-86; Lewis L. Strauss, *Men and Decisions* (Garden City, N.Y.: Doubleday and Co., 1962), pp. 181-82.

[20] Groves, *Now It Can Be Told*, p. 36; *Marshall Diary*, 7 and 12-13 Sep 42, MDR; DSM Chronology, 13 Sep 42, Secs. 2(e) and 20, OROO.

Heavy water was another matter. Scientific leaders knew that heavy water could not be available in large quantities for many months or even years. Researchers at the Metallurgical Laboratory had directed their primary interest toward developing a uranium-graphite pile, viewing heavy water as an alternate solution should the problems with graphite prove insuperable. Meanwhile, the OSRD moved ahead with its plans for a heavy water plant at Trail (*see Map 2*), but priority difficulties delayed construction and the plant did not begin operating until June 1943.[22]

A store of approximately 400 pounds—almost all the heavy water in the world outside of that being produced by the German-controlled Norsk Hydro plant in southern Norway—was in the hands of British scientists. This heavy water had an interesting history. Nuclear research in France by Frederic Joliot-Curie and his collaborators, Hans von Halban and Lew Kowarski, had concentrated on using heavy water as a moderator to achieve a slow-neutron reaction. In March 1940, just before the German attack on Norway, Joliot-Curie had secured about 160 to 165 liters (169 to 174 quarts) of heavy water from Norsk Hydro. Shortly before the fall of Paris in mid-June, he sent von Halban and Kowarski with most of this precious store to England, where, after a hazardous trip, the two men joined the growing team of British and refugee scientists doing atomic research. Work with this stock of heavy water had contributed to the optimistic British reports on a uranium–heavy water system. When the group relocated to Canada at the end of 1942, the heavy water went along.[23]

The need for large quantities of silver had not been anticipated. At the Army-OSRD meeting on 9 July, Ernest Lawrence of the University of California, Berkeley, pointed out that he needed several thousand tons of copper for magnet coils. Because copper was high on the list of critical materials and might be impossible to obtain, he thought that silver, a good electrical conductor and not on the critical materials list, would do as well. Accordingly, Colonel Nichols visited Under Secretary of the Treasury Daniel W. Bell to find out if silver would be available. Although Nichols did not provide specific details of the DSM project, Bell appeared receptive. "How much silver do you want?" he asked. "About fifteen thousand tons," answered Nichols. Visibly startled, Bell exclaimed: "Young man, . . . I would have you know that when we talk of silver we speak in terms of ounces." [24]

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[21] Smyth *Report*, pp. 65–68 (quotation from p. 68); Compton, *Atomic Quest*, pp. 97–98; MDH, Bk. 1, Vol. 4, "Auxiliary Activities," pp. 12.7–12.9, DASA.

[22] Smyth *Report*, p. 65; Compton, *Atomic Quest*, pp. 79 and 98–99; Marshall Diary, MDR, and DSM Chronology, OROO, for the summer of 1942, passim; MDH, Bk. 3, "The P–9 Project," pp. 4.1–4.7 and 5.4, DASA.

[23] H. D. Smyth, "British Information Service Statement, 'Britain and and the Atomic Bomb,' August 12, 1945," in *Atomic Energy for Military Purposes*, 8th ed. (Princeton, N.J.: Princeton University Press, 1948), p. 276; Gowing, *Britain and Atomic Energy*, pp. 49–51; Crowther and Whiddington, *Science at War*, pp. 144–45 and 148; Sir George Thomson, "Anglo-U.S. Cooperation on Atomic Energy," *American Scientist*, 41 (Jan 53): 77–78 and 80; Glasstone, *Sourcebook on Atomic Energy*, 3d ed. (Princeton, N.J.: D. Van Nostrand Co., 1967), n. on p. 513. The figure given for the amount of heavy water that the French secured from Norsk Hydro varies somewhat in the different accounts. Most state that there were about 160 to 165 liters, an amount that would have weighed about 176 to 182 kilograms (388 to 410 pounds).

Ounces or tons, that the DSM project would get what it wanted was soon clear. With relatively good speed, considering the need for secrecy and the number of clearances required, the Department of the Treasury, the ANMB, and the WPB approved the necessary arrangements. On 29 August, in a letter to Secretary of the Treasury Henry Morgenthau, drafted jointly by Manhattan and Treasury representatives, Secretary of War Stimson requested the transfer of 175 million fine troy ounces (about 6,000 tons of silver) "to the War Department to be used as a substitute for copper" for an "important project" that was "highly secret." "At this time," read Stimson's letter, "the interests of the Government do not permit my disclosing the nature of the use." [25]

The endorsement of the Treasury Department on a second letter that day constituted an agreement between the two agencies for the transfer. It provided that the silver would remain in the United States; would be returned to the Treasury in five years, or sooner if required; would be utilized in government-owned plants essential to the war effort; and would be protected against loss. Subsequent agreements in 1943 and 1944 would raise the quantity involved to roughly 14,700 tons, worth about $304 million.[26] Under constant heavy guard, the bars of silver were transferred—after being melted, cast in cylindrical billets, rolled into strips, and finally fabricated into magnet coils. Because the electromagnetic process seemed the most promising in the summer of 1942, this turn of events was indeed encouraging.

Site Selection

Project leaders in the summer of 1942 were well aware that acquisition of suitable sites was as important to the success of the atomic program as obtaining adequate priorities. At the Army-OSRD meeting of 25 June, they had confirmed an earlier decision to build a heavy water plant at the Trail site and approved location of the proposed plutonium pilot plant in the Argonne Forest near Chicago. The Army delayed actual acquisition of a specific area in the Argonne Forest preserve pending receipt of further

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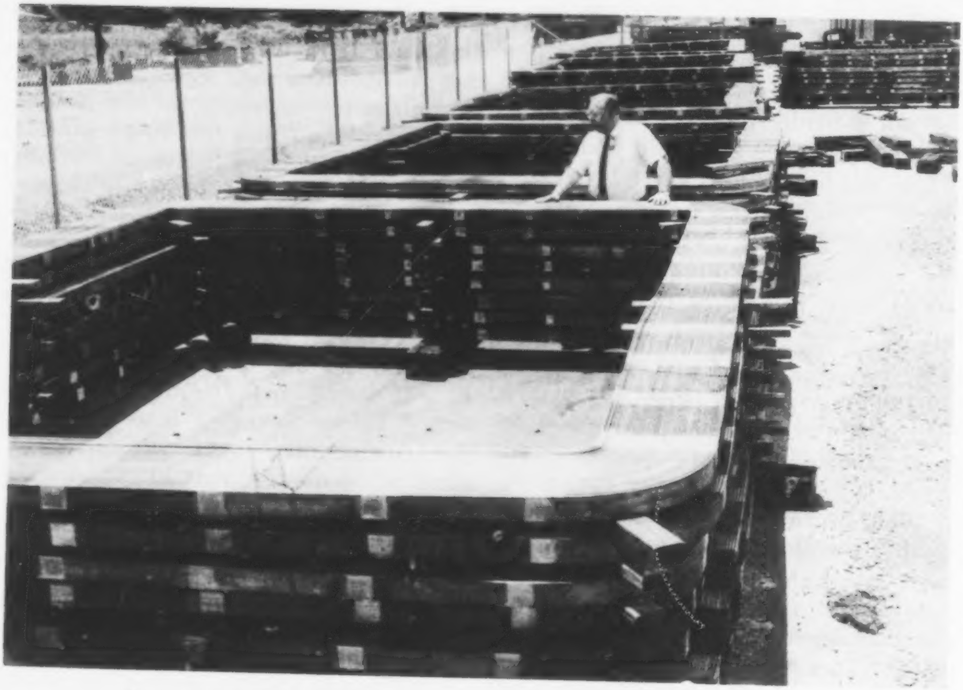
[24] As related by Compton, *Atomic Quest*, p. 157. Subsection based on Marshall Diary, 9 Jul–29 Aug 42, MDR; MDH, Bk. 5, Vol. 4, "Silver Program," DASA; Groves, *Now It Can Be Told*, pp. 107–09. Groves gives the impression that Marshall himself visited Under Secretary Bell, but Marshall's 3 Aug 42 entry in his diary indicates that he sent Nichols to confer with Bell on the question of securing silver for the Manhattan Project.

[25] Ltr, Stimson to Secy Treas, 29 Aug 42, in MDH, Bk. 5, Vol. 4, App. B–1, DASA.

[26] The Atomic Energy Commission did not return the last of the 14,700 tons of silver to the U.S. Treasury until May 1970, a quarter of a century later. See news item in *Washington Post*, 29 May 70.



SILVER-WOUND MAGNET COILS FOR THE ELECTROMAGNETIC PROCESS

information from the Metallurgical Laboratory concerning the size of site needed for the plutonium pilot plant. In early July, Colonel Nichols obtained clarification of the specific Argonne requirements in discussions held in Chicago with Stone and Webster officials and Compton and his staff, opening the way for lease in August of 1,000 acres from Cook County. At the same time, the University of Chicago agreed to provide an additional acre on the campus for future construction of additional laboratory space. To administer the site acquisitions and oversee construction activities, Colonel Marshall established the Chicago Area Engineers Office in August and assigned Capt. James F. Grafton as area engineer.[27]

For the main production plants, Colonels Marshall and Nichols and representatives of Stone and Webster and the Tennessee Valley Authority (TVA) began a survey of possible sites in the Knoxville area on 1 July.[28]

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[27] Marshall Diary, 6–7, 10, 13, 17 Jul and 13 Aug 42, MDR; MDH, Bk. 4, Vol. 2, "Research," Pt. 1, pp. 2.5–2.7 and 7.2, DASA.

[28] Paragraphs on Tennessee site based on Marshall Diary, 1–3, 9, 10, 14, 15, 23, 29, 31 Jul and 3, 17–19, 26–27 Aug and 2–5, 10 Sep 42, MDR; MDH, Bk. 1, Vol. 10, "Land Acquisition CEW," pp. 2.3–2.4 and 2.20–2.21, and Vol. 12, "Clinton Engineer Works," pp. 2.2–2.4, DASA; DSM Chronology, 9, 30 Jul and 26 Aug 42, each Sec. 2(e), OROO; Groves, *Now It Can Be Told*, p. 15; Memo, Crenshaw to Dist Engr, sub: Weekly Progress Rpt, 22 Aug 42, Admin Files, Gen Corresp, 001 (Mtgs), MDR.

(*See Map 1.*) Requisite conditions for the site were a nearby source of a large amount of continuous electric power, enough for a fair-sized city; availability of a very large quantity of water for cooling and processing as well as construction and operating requirements; and proximity to a main line railroad and good access roads, to ensure delivery of heavy construction materials and supplies. Topography, too, was important. An area bounded by natural barriers, such as rivers and hills, would be securer and individual plant sites separated by ridges far safer in case of an explosion, although the slopes of these ridges should be gentle enough for easy construction. The substratum should provide adequate foundation, yet not be so full of rocks as to make excavation unnecessarily difficult and time-consuming. Finally, there should be adequate and suitable space for a town with facilities for housing and serving thousands of workmen and technicians and their families.

The survey and subsequent investigations filled nearly three days, during which Colonel Marshall and his colleagues examined several possible sites. None seemed at first glance exactly right, but one, at least, had possibilities. TVA officials seemed certain that the 150,000-kilowatt power requirement of the plants could be met if Marshall could hasten the delivery of some badly needed heavy-generating equipment. As project priorities were indefinite at this time, Marshall agreed to look into the matter; however, he emphasized that because an entirely suitable site had not been found, he would have to consider an area near Spokane, Washington, where the Bonneville Power Administration might more easily meet his requirements.

Site problems were a key issue at the next Army-OSRD meeting on 9 July. John R. Lotz, head of Stone and Webster, reported that his firm had surveyed the Spokane area and concluded that it lacked sufficient transmission lines to supply the required power. The group reaffirmed in principle its earlier decision for a site in Tennessee. Also, Marshall and the Stone and Webster engineers agreed that half of the 200 square miles previously believed necessary would be adequate, and even a site of this size would not be required were it not for the plutonium plant. The danger of highly radioactive fission products escaping, or even of a nuclear explosion, dictated building this plant 2 to 4 miles from any other installation and an equal distance in from the boundaries of the site.

The 9 July Army-OSRD meeting ended without a decision on a specific Tennessee site or any indication of when one might be made. Nor was there, for that matter, any clear forecast of scientific developments that might help determine the choice. Only a tentative and, as soon became clear, excessively optimistic construction schedule emerged. As Colonel Groves pointed out to Colonel Marshall that afternoon, a general air of vagueness seemed to pervade the whole atomic project, with the starting dates for development of many of its phases still too indefinite. He urged Marshall first to insist upon the prompt and complete programming of all contemplated steps and then to see that this schedule was adhered to as far as possible. An obvious necessity was a swift decision on the major production site.

Shortly thereafter, Marshall and Stone and Webster officials agreed to try to obtain a site in Tennessee by 10 August so that construction on the project administration building and some housing facilities could begin, even if plant construction could not. Stone and Webster drew up a formal site report on the most promising area, about 12 miles west of Knoxville, and prepared maps indicating the exact tracts of land to be acquired. To avoid having a public highway run through the site, an obvious security hazard, the firm also studied the possibility of relocating Tennessee 61, which then crossed the northern portion of the area. The Ohio River Division of the Engineer Department then prepared an appraisal of the cost of acquiring the approximate 83,000 acres in the area, comprised of land in the Roane, Loudon, Knox, and Anderson Counties of Tennessee. On 30 July, at the next Army-OSRD meeting, Colonel Marshall reviewed the steps taken toward acquisition of the site and the entire group agreed that the Tennessee Valley seemed the best location, although some of the scientists felt that a site farther east in the Great Smoky Mountains, where the climate was not as warm, might prove more desirable in the future for a proposed permanent central laboratory.

Hardly had the way been cleared for immediate acquisition of the Tennessee site when Colonel Marshall, with the approval of General Robins, decided to postpone carrying it out. He knew that the site and making the necessary pre-construction changes and improvements, not including relocation of Tennessee 61, would cost an estimated $4.25 million and require resettlement of some 400 families living in the area. Marshall reasoned there could be no harm in delaying acquisition until more definite information on the plutonium process was available. At worst, a postponement would cause only a few weeks delay, for the Engineers' Real Estate Branch was sure that the land could be acquired to the point of right of entry within ten days of his order to proceed. Meanwhile, he would try to get the TVA the needed priorities and, when scientific developments warranted, order acquisition of the site.

Although Ernest Lawrence indicated he was now willing to have the full-scale electromagnetic separation plant built in Tennessee, locating the plants in the Shasta Dam area of California was seriously studied and the proposal was not completely abandoned until early September. Nevertheless, Colonel Marshall felt he was "about ready to recommend purchase of at least part of the Tennessee site" by 26 August, the next S–1 Executive Committee meeting. When the committee, however, delayed a decision on production facilities, acquisition of the site was postponed, despite the urgings of Robins and Groves to the contrary.[29]

Reaching Decisions: The Meeting at Bohemian Grove

About 10–12 miles northwest of San Francisco, across the Golden Gate and amidst the giant redwood trees of the Muir Woods National Monument, there is a beautiful area known as the Bohemian Grove. In this impressive setting, not too far from Lawrence's laboratory at the University of California, Berkeley, the S-1 Executive Committee met on 13 and 14 September 1942 to consider at length and in detail the major problems of the DSM project.[30] Present along with the committee at this fifth Army-OSRD meeting were Colonel Nichols and the California area engineer, Maj. Thomas T. Crenshaw—both in civilian clothes to mask from casual observers the Army's interest in the work at Berkeley—as well as J. Robert Oppenheimer and two other scientific consultants.

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[29] Marshall Diary, 26 Aug 42, MDR.

The first major decision was to acquire the Tennessee site immediately. But on which plants could construction begin? The gaseous diffusion and centrifuge separation methods still appeared feasible and promising, but neither had produced any appreciable amounts of U-235 and both would require hundreds or thousands of process stages for large-scale separation. The plutonium process had yet to see a self-sustaining chain reaction, much less production and separation of plutonium. Thus far, only the electromagnetic method had achieved significant production. Because one electromagnetic unit could separate 10 milligrams of U-235 per day, it was not inconceivable that fifty thousand units could separate a pound, and, in the same period, a billion units could separate a ton. To design and build these units would be difficult and expensive, and the full-scale plant would require considerably more research and engineering development as well as the training of large numbers of skilled operators. But the process appeared sufficiently feasible to justify starting work on a production plant. After a visit to Lawrence's laboratory, where the Executive Committee viewed experimental separation units in actual operation, the group agreed to proceed with the construction of a large-scale electromagnetic plant.

This 100-gram-per-day (the output specified in the 17 June program) electromagnetic installation would be erected in Tennessee at an estimated cost of $30 million. Design and procurement for the plant were to begin immediately, subject to cancellation at any time before New Year's Day of 1943 if further developments so warranted. On that date, the group hoped, design would be frozen and construction could begin. At the same time, a small electromagnetic pilot plant was projected for Tennessee; however, at a later date, this plan was dropped.

The experimental plutonium plant planned for the Argonne Forest site was now switched to Tennessee. This change was necessitated by growing evidence that operations at this plant—including chemical studies on extracting the plutonium, training of operators, and testing of equipment and processes—would be on a scale too large for the Argonne site. Stone and Webster would arrange a subcontract with a chemical company to develop and operate the chemical engineering equipment needed for plutonium separation. Now the experimental pile from the Metallurgical Laboratory could be relocated from the heart of south Chicago to the safer Argonne location. In further support of the plutonium project, construction of the heavy water plant at Trail would be pushed as rapidly as necessary to complete this work by 1 May 1943.

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[30] Section on Bohemian Grove meeting based on Compton, *Atomic Quest*, pp. 150–54 and photograph facing p. 140; Marshall Diary, 13 Sep 42, MDR; DSM Chronology, 13–14 Sep 42, Sec. 2(e), OROO; Smyth *Report*, pp. 140–41.

The meetings on 13 and 14 September brought an end to much of the indecision that the course of events had imposed on the atomic energy program during the summer of 1942. The decisions reached at the Bohemian Grove, in the words of one participant, "were destined to shape the entire future development of the project."[31] Indeed, even as these decisions were taking form, changes were under way that would have a profound effect on the organization and direction of the atomic bomb program. The early period of Army participation, marked by a slow and deliberate entrance into the project, was coming to an end.

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[31] Compton, *Atomic Quest*, p. 150.

CHAPTER IV

General Groves Takes Command

As the son of an Army chaplain, Leslie R. Groves spent many of his boyhood years on different military posts in the western United States. During these formative years, young Groves often listened to the old Indian fighters who frequented the posts recount many a stirring tale of how the West was won. Their tales fired the boy's imagination, yet he lamented that those days were past and that there were no more frontiers left for him to conquer. He could not know, of course, that the opportunity to realize his youthful dreams to lead in the exploration and conquest of a new frontier—his to be a scientific and technical one whose developments would have a decisive impact on the future and fate of all mankind—would come as the result of the administrative reorganization of the American atomic energy program in the summer and fall of 1942 and his selection as a 46-year-old career Army officer to be officer in charge of the project.[1]

Reorganization and the Selection of Groves

On 17 June 1942, President Roosevelt had approved the proposals, made by Vannevar Bush and James B. Conant to the Top Policy Group, that the Army assume overall direction of the atomic program and that the Joint Committee on New Weapons and Equipment (JNW) establish a special subcommittee to consider the military application of atomic energy. Bush, however, who served as JNW chairman, did not see any need for immediate appointment of the subcommittee and thus waited until 10 September to propose to Secretary of War Stimson that a small group of officers be assigned the task of considering possible strategic and tactical uses of atomic energy. When Stimson informed Army Chief of Staff General George C. Marshall of Bush's request, the general indicated that he felt it was premature and expressed grave concern about the increasing problem of security as more and more people became aware of the existence of the atomic energy program. Despite Marshall's reservations, it soon became evident that a special committee was needed not only to consider the ultimate uses of atomic energy but also to determine general policies and supervise the growing project. The sequence of events in September 1942 that led to formation of a policymaking committee and to strengthening the military leadership of the project seems to have been about as follows.[2]

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[1] Groves, *Now It Can Be Told*, p. 415.

Early that month—almost certainly before learning the results of the Bohemian Grove meeting and possibly even before Bush made his recommendations to Stimson—General Styer discussed the status of the atomic energy program with his commander, Lt. Gen. Brehon B. Somervell, Services of Supply (SOS) commanding general, and then with General Marshall. In outlining developments in the program, he emphasized that the Army's responsibilities were now becoming increasingly large. Then on the sixteenth, or possibly a day or so earlier, Bush, Styer, and Somervell met to discuss the top-level organization of the atomic project. Under Secretary of War Robert P. Patterson also may have been present, or perhaps Somervell saw him separately. At any rate, two decisions were reached: A policy committee would be formed to oversee the program, and an Army officer would be chosen to carry out the policies established by this committee.

Anxious to counteract General Somervell's tendency to favor giving the Army dominant control of the project, thus relegating the scientists to a lesser role, Bush proposed that the committee should be organized first. Styer and Somervell, however, wanted to choose an officer immediately. The obvious choice was Styer himself, but the job was a full-time one and Somervell was unwilling to lose his chief of staff. Styer then, without hesitation, proposed Colonel Groves, a recommendation readily approved by Generals Somervell and Marshall.

In addition to his impressive general qualifications,[3] another factor made

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[2] Description of events through 22 Sep 42 reconstructed from Memo, Bush and Conant to Wallace, Stimson, and Marshall, sub: Atomic Fission Bombs, 13 Jun 42, Incl to Ltr, Bush to President, 17 Jun 42; Ltr, Bush to Styer, 19 Jun 42. Both in HB Files, Fldr 6, MDR. Stimson Diary, 10 Sep 42, HLS. Memo, Bundy to Stimson, 10 Sep 42, HB Files, Fldr 5, MDR. 1st Ind, Styer to Chief of Mil Hist, 15 Aug 61, to Ltr, Chief of Mil Hist to Styer, 17 Jun 61, CMH. Groves, *Now It Can Be Told*, pp. 3–5 and 21–23. Marshall Diary, 16–21 Sep 42, OCG Files, Gen Corresp, Groves Files, Misc Recs Sec, behind Fldr 5, MDR. Memo (penciled note), VB [Bush] to Bundy, in envelope marked 9/17, HB Files, Fldr 7, MDR. Diary of Lt Gen Leslie R. Groves (hereafter cited as Groves Dairy), 17–22 Sep 42, LRG. The diary was an office record maintained by Groves's secretaries to list visits, telephone calls, etc. It covers the period from 1 Jan 42 to 7 Nov 45. Entries of later years are more complete than for the early period of the Manhattan Project. No entry was written by Groves, nor was each one necessarily seen by him. It appears to be accurate, although incomplete.

[3] Leslie R. Groves entered the U.S. Military Academy in 1916 following three years as a student at the University of Washington (1913–14) and the Massachusetts Institute of Technology (1914–16). His class at West Point did not graduate until November 1918, too late for him to see active duty in World War I. Assigned to the Corps of Engineers, for more than a decade after the war he held a variety of engineer positions in the United States, Hawaii, and Nicaragua. During the 1930's, he attended the Command and General Staff School at Fort Leavenworth, Kansas, and the Army War College in Washington, D.C., and also served in the Office of the Chief of Engineers (OCE), on the Missouri River Division staff, and on the War Department General Staff. Beginning in 1940, he held important administrative posts in the rapidly expanding military construction program, moving quickly from the rank of captain to full colonel. As chief of the Operations Branch, Office of the Quartermaster General (OQMG), he acted as special assistant to the quartermaster general for Army construction. When the Construction Division was transferred from OQMG to OCE at the end of 1941, he became deputy chief of the division under Brig. Gen. Thomas M. Robins. Having an excellent background of experience on a variety of major construction projects, the best known being the huge Pentagon

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Groves the logical choice to head the atomic project: As deputy chief of the Engineers' Construction Division, he had spent considerable time advising District Engineer Marshall in his quest for power resources and in his selection of sites for the Manhattan District facilities. Furthermore, with military construction in the United States past its wartime peak, Groves was seriously considering taking another assignment, probably overseas.

On the morning of 17 September, Groves had to testify on a military housing bill before the House Military Affairs Committee. When he left the hearing room, he encountered General Somervell and learned of his new assignment. Groves later recalled that his first reaction was one of great disappointment at the prospect of missing overseas duty. Somervell, undoubtedly sensing Groves's lack of enthusiasm for his new job, expressed the opinion that a successful conclusion to the atomic energy program could well have a decisive impact on winning the war.[4]

Shortly after leaving Capitol Hill, Groves, accompanied by Colonel Nichols (Colonel Marshall was on the West Coast), reported to General Styer for orders. Styer explained the new high-level organization of the project and Groves's role in it. Groves was to be relieved of his position in the Construction Division. He was, however, to continue to exercise control over construction of the nearly completed Pentagon. In this way he would avoid arousing public curiosity at his sudden absence from this project, which was viewed with great interest by Congress. After the Pentagon job was finished in a few months, Groves was to devote himself entirely to the atomic energy program.

The directive for Groves's new assignment—Styer had consulted with him on its wording—ordered the Engineers chief, General Reybold, to relieve him "for special duty in connection with the DSM project."[5] The directive emphasized, however, that Groves was to operate closely with the Construction Division and other elements of the Corps of Engineers. He was to have full responsibility for administering the entire project and to make immediate arrangements for priorities, for formation of a committee to formulate military policy governing use of the project's product output, and for procurement of the Tennessee site as the location for its major activities. He was also instructed to make plans for the organization, construction, operation, and security of the project and, after they had been approved, to undertake the measures necessary to carry them out.

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building. Groves earned the reputation among his professional colleagues as an able, aggressive, and industrious officer who repeatedly demonstrated superior engineering, administrative, and organizational abilities. See 1st Ind, Styer to Chief of Mil Hist, 15 Aug 61, to Ltr, Chief of Mil Hist to Styer, 17 Jul 61, CMH; WD Press Release, Oct 46, CMH; Groves, *Now It Can Be Told*, p. 465; Fine and Remington, *Corps of Engineers: Construction*, pp. 158–59 and 254–55. A detailed listing of Groves's military assignments may be found in Cullum, *Biographical Register*, 6B:2010, 7:1338, 8:382, 9:271.

[4] Groves, *Now It Can Be Told*, pp. 3–4; Fine and Remington, *Corps of Engineers: Construction*, pp. 586–603.

[5] Memo, Somervell to Chief of Engrs, sub: Release of Groves for Special Assignment, 17 Sep 42, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab B, MDR. Directive to Groves reprinted in his book *Now It Can Be Told*, App. 1, pp. 417–18.

Styer also informed Groves that General Marshall had directed that he be promoted to the grade of brigadier general. As the list of new promotions would be out in a few days, Groves suggested (and Styer agreed) that he should not take over the project officially until he had received his star. "I thought that there might be some problems in dealing with the many academic scientists involved in the project," he wrote later, "and I felt that my position would be stronger if they thought of me as a general instead of a promoted colonel." The new military chief of the atomic project, however, seems not to have considered that for several months Colonel Marshall and other officers had been dealing successfully with project scientists in spite of their relatively low military rank.[6]

Following the conference with Styer, Groves delivered the directive covering his new assignment to General Reybold and also stopped in the office of his erstwhile chief, General Robins, to brief him on its contents. He then sat down with Colonel Nichols to learn from the deputy district engineer more about the actual status of the project. He was not very pleased with what he learned. "In fact," he recalled subsequently, "I was horrified. It seemed as if the whole endeavor was founded on possibilities rather than probabilities."[7]

On the afternoon of the same day (17 September), Groves and Nichols called on Bush. Unfortunately, no one had yet officially informed the OSRD director of Groves's assignment to the project. Furthermore, Bush was disturbed that this action was additional evidence that Somervell was intent on having the Army take over control of the atomic energy program to the complete exclusion of the scientists. Consequently, he was most reluctant to answer Groves's questions and the whole conversation was somewhat one-sided, relatively brief, and, in Groves's words, "far from satisfactory for both of us."[8]

As soon as Groves departed, Bush hurried over to see Styer. He repeated his views that the proposed policy committee should choose its own agent; he "doubted whether he [Groves] had sufficient tact for such a job." Bush recollected later that Styer disagreed with him on the first point and, while acknowledging that Groves was "blunt etc., . . . [he] thought his other qualities would overbalance." Styer went on to explain that Groves's assignment already had been approved by General Marshall. Returning to his office, Bush wrote to Harvey Bundy, Stimson's assistant for scientific matters: "I fear we are in the soup."[9]

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[6] Groves received the grade of brigadier general on 23 Sep 42 and, subsequently, the grade of major general on 9 Mar 44, a rank he continued to hold for the rest of the time he served as commander of the Manhattan Project. He moved up to the rank of lieutenant general, effective 24 Jan 48, but shortly thereafter (29 Feb 48) retired from active duty on his own application. At the time of his retirement, Congress enacted a special measure giving him the honorary rank of lieutenant general, effective 16 Jul 45, in recognition of his services in directing the atomic bomb project. See Cullum, *Biographical Register*, 9:271. Quotation is from Groves, *Now It Can Be Told*, p. 5.

[7] Groves, *Now It Can Be Told*, p. 19.

[8] Ibid., p. 20. See also Hewlett and Anderson, *New World*, p. 81.

[9] Paragraph on Bush's reaction to Groves's assignment based on Memo, Bush to Bundy, in envelope marked 9/17, MDR.

For the next few days, Groves was busy preparing for his new assignment, including conferences with Colonel Marshall and Generals Styer and Robins. Robins made a point that the Engineer Department of the Corps of Engineers would have no further responsibility for the program and that the Manhattan District would henceforth report to Groves rather than to the Engineers chief.

On 21 September, Colonels Groves and Marshall called on Bush. This time the OSRD director was cordial and open. He explained his earlier reluctance to talk freely, then briefed Groves thoroughly on the scientific and historical background of the project and cautioned him on the need for tightening security measures. Thus, from what Groves himself later termed an "inauspicious beginning," relations between the two leaders of the atomic project soon grew into a firm and fruitful friendship, with each expressing the greatest respect for the other's capabilities.[10]

On the afternoon of 23 September, a few hours after Groves had been sworn in as a brigadier general and had taken official charge of the atomic project, he went to a meeting convened by Secretary Stimson at the War Department. Present also were Bush, Conant, Bundy and Generals Marshall, Somervell, and Styer. The group agreed to establish a small Military Policy Committee, responsible to the Top Policy Group, to formulate project policies on research and development, construction and production, and strategic and tactical matters. Bush was chosen chairman, with Conant as his alternate; the other members were General Styer and Rear Adm. William R. Purnell, who had replaced Rear Adm. Willis A. Lee, Jr., on the JNW Committee. General Groves was to sit with the committee and to act as its executive officer in carrying out its policies. The new committee was directed to report periodically to the Top Policy Group. The OSRD S-1 Executive Committee was to continue to advise on scientific aspects of the program, with most of the research activities under OSRD direction.[11]

As soon as the Military Policy Committee had received written approval from the Top Policy Group and the JNW Committee, it assumed virtually complete control of all aspects of the atomic energy program, acting through General Groves as, to use Stimson's phrase, "the executive head of the development of the enterprise."[12]

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[10] Quoted phrase from Groves, *Now It Can be Told*, p. 21. Bush acknowledges in his memoirs that Styer "was right when he insisted that Groves was the man for the job" [see Varnevar Bush, *Pieces of the Action* (New York: Willliam Morrow, 1970), p. 61]. Groves implies in his account (pp. 21-22) that his second meeting with Bush occurred on 19 September, whereas the Marshall Diary, 21 Sep 42, MDR, indicates that the meeting actually took place on the twenty-first. Groves saw Styer again on the twenty-second, but he fails to mention this meeting in his book. Curiously enough, however, the two pages describing the events of that date are missing from both copies of the Marshall Diary, and although the Groves Diary, 22 Sep 42, LRG, records the fact that the meeting took place, no other details are given.

[11] Rpt, Bundy, sub: S-1 Mtg at Secy War's Office, 23 Sep 42; Memo A, signed by all Top Policy Group (except President) and JNW members, 23 Sep 42; Ltr, Bush to Patterson, 13 Oct 45. All in HB Files, Fldr 6, MDR. DSM Chronology, 26 Sep 42, Sec 2(e), OROO. Smyth *Report*, pp. 59-60.

[12] Stimson Diary, 23 Sep 42, HLS.

First Measures

Acquiring the Tennesssee Site

Making a hurried departure from the 23 September meeting at the War Department, Groves went directly to Union Station and caught an overnight train for Knoxville, Tennessee.[13] (*See Map 1.*) The next morning he met Colonel Marshall, who had been rechecking the proposed site for the project. Groves and Marshall spent the day going over the site as carefully and thoroughly as was practicable on existing roads. "It was evident that it was an even better choice than . . . [he] had anticipated."[14] Well satisfied that the site would meet all requirements, and knowing that preliminary steps for acquisition were under way, Groves telephoned Col. John J. O'Brien of the Engineers' Real Estate Branch to proceed at once with formal acquisition.

The roughly rectangular site, about 16 miles long and 7 miles wide, covered substantial portions of both Roane and Anderson Counties. It was located approximately midway between the two county seats, Kingston and Clinton, and about 12 miles west of Knoxville, the nearest city. Bounded on three sides by the meandering Clinch River and on the northwest by Black Oak Ridge, the terrain of the site was typical of the region. Wooded ridges, running more or less parallel to its long axis, rose generally about 200 feet above narrow valleys. Of the approximately one thousand families, most resided on farms or in one of several small hamlets.

On 29 September, Under Secretary of War Patterson authorized the Engineers to acquire the some 56,000 acres at an estimated cost of $3.5 million. Subsequent additions brought the total to about 59,000 acres. On 7 October, a court-approved condemnation for the whole area went into effect, and within a month the first residents began to leave. Construction began almost immediately. Ultimate acquisition of the entire site would not be completed without many problems, but now, at least, the first essential step toward building the great plants for producing fissionable materials had been taken.[15]

For security reasons earliest public references to the site indicated it was an artillery and bombing practice area, and for several weeks it was known as the Kingston Demolition Range. The official designation, however, and the name that was released to the public in late January 1943, was the Clinton Engineer Works. Project leaders chose the name of the town located a few miles northeast of the site as being least likely to draw attention to the atomic energy activities at the site. The Clinton Engineer Works continued to be the Tennessee area's official designation as long as it remained under Army control. In mid-1943, when permanent housing for the site's growing population was erected along Black Oak Ridge, the townsite became known as Oak Ridge, and this name was used as the post office address.[16]

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[13] Subsection based on Marshall Diary, 29–31 Jul and 19, 23, 24, 26 Sep 42, MDR; Ltr, Robins (Act Chief of Engrs) to CG SOS, sub: Acquisition in Fee of Approx 56,200 Acres of Land for Demolition Range Near Kingston, Tenn., and Inds, 29 Sep 42, Incl to Memo, O'Brien to Lt Col Whitney Ashbridge (CE Mil Constr Br), sub: Land Acquisition in Connection With MD, 17 Apr 43, Admin Files, Gen Corresp, 601 (Santa Fe), MDR; Groves, *Now It Can Be Told*, pp. 24–26; MDH, Bk. 1, Vol. 10, "Land Acquisition CEW," p. 2.21 and App. F1, and Vol. 12, "Clinton Engineer Works," pp. 2.6–2.8, DASA; George O. Robinson, Jr., *The Oak Ridge Story* (Kingsport, Tenn.: Southern Publishers, 1950), p. 27.

[14] Groves, *Now It Can Be Told*, p. 25.

[15] Land acquisition problems are dealt with in Ch. XV.

Procuring Uranium

Whether the Manhattan Project had sufficient uranium ore to fulfill its mission, Groves felt, was of paramount importance.[17] Immediately after his 17 September departure from the Corps and before he officially assumed his new position as Manhattan commander, he took steps to ascertain the availability of uranium to the project. Informed by Colonel Nichols of the contracts already made with Edgar Sengier of Union Miniere and of the Bohemian Grove decision to acquire the company's reserve of ore on Staten Island, Groves directed Nichols to press the negotiations with the mining executive.

During the previous week Colonel Nichols, Capt. John R. Ruhoff, assistant chief of the District's Materials Section, and officials of the Standard Oil Development Company and the Stone and Webster Engineering Corporation had agreed that Ruhoff should arrange for a test of the Staten Island ore to determine the percentage of recoverable U_3O_8 (uranium oxide) and, on the fifteenth, Ruhoff had secured Sengier's release of 100 tons for shipment to Eldorado Gold Mines' Port Hope refinery. In the meantime, Nichols had obtained the necessary export licenses through the State Department.

In follow-up negotiations with Sengier on 18, 23 and 25 September, Nichols arranged for procurement of the Staten Island ore. The time required to work out the necessary arrangements with both Eldorado Gold Mines and its marketing agent, the Canadian Radium and Uranium Corporation, delayed signing of the contract until 19 October. It called for purchase by the United States of the uranium content of 100 tons of ore, with Union Miniere's African Metals retaining ownership of the radium in the ore. Also, the United States was to have an option to purchase the remaining 1,100 tons of uranium ore on Staten Island, assayed at 65 percent uranium oxide, as well as about twice that amount of approximately 20 percent ore in storage in the Belgian Congo. Except for that ore shipped immediately to Port Hope for processing (the first 100 tons reached there in November), all Staten Island ore was to be transferred to Seneca Ordnance Depot at Romulus, New York, for safekeeping. Subsequent contracts covered purchase of additional Congo uranium on terms similar to those set forth in the 19 October agreement.

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[16] *Knoxville Journal*, 31 Jan 43; Groves, *Now It Can Be Told*, pp. 25–26. Groves notes that not until establishment of the AEC in 1947 did the name *Oak Ridge* become the official designation of the Tennessee project.

[17] Subsection based on Memo for File, Merritt, sub: Foreign Sources of Material Which Should Be Further Investigated, 23 Feb 43; Memo, Merritt to Nichols, sub: Resume of Production of Uranium Products for MD in Colorado Plateau Area, 26 Jan 45. Both in Admin Files, Gen Corresp, 410.2 (Uranium), MDR. Rpt, Military Policy Committee to Top Policy Group, sub: Present Status and Future Prgm (hereafter cited as MPC Rpt), 15 Dec 42, Incl to Ltr, Bush (for MPC) to President, 16 Dec 42, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab B (original of covering letter, with Roosevelt's approval, filed herein), MDR. Marshall Diary, 14 Sep–15 Oct 42, MDR. Ltr, Bush to Styer, 11 Sep 42, OSRD. Memo, [Ruhoff] to Groves, sub: Summary of Ore Contracts, 15 Feb 44, Admin Files, Gen Corresp, 161 (African Metals), MDR. Contract W–7405–eng–4 (signed by Nichols and Sengier), 19 Oct 42, OROO. Kenneth D. Nichols, Comments on Draft Hist "Manhattan: The Army and the Atomic Bomb," Incl to Ltr, Nichols to Chief of Mil Hist, 25 Mar 74, CMH. MDH, Bk. 7, Vol. 1, "Feed Materials and Special Procurement," passim, DASA. Smyth *Report*, p. 66. Compton, *Atomic Quest*, pp. 96–97. Groves, *Now It Can Be Told*, pp. 33–37.

Working in close consultation with Maj. Gen. Charles P. Gross, the Army's Transportation chief, Manhattan officials arranged for shipping the ore from Africa by the safest and swiftest means available. Based upon Sengier's recommendations, fast motor ships traveling out of convoy were employed to traverse the submarine-infested South Atlantic. Because the ore arrived at the port of New York considerably faster than it could be refined, it was assayed and stored in a warehouse at Middlesex, New Jersey, especially leased by the Army for that purpose.[18]

In a move to further expedite the uranium progam and, at the same time, to relieve overburdened Stone and Webster of part of its extensive assignment, the Manhattan District assumed responsibility for procurement and preliminary refining of the ore. Capt. Phillip L. Merritt, a trained geologist who was already on the staff, was assigned to monitor these activities. Working under the general guidance of Colonel Nichols, Merritt gave special attention to the project's worldwide search for possible additional sources of uranium.

Toward the end of 1942, the Eldorado mine in Canada resumed operations. Meanwhile, the District made arrangements for uranium extraction from tailings of Colorado Plateau carnotite ores mined originally for their radium and vanadium content. In January 1943, the War Production Board (WBP) issued orders (subsequently amended in August) that future sale or purchase of uranium compounds was limited to the atomic program, except for essential military and industrial applications. Even before the board acted, Manhattan's Military Policy Committee had reported optimistically to the President that the project had "either in hand or on the way, sufficient uranium for the entire program up to and including military use."[19]

Obtaining Priority Ratings

In June 1942, President Roosevelt had endorsed a recommendation by the Top Policy Group that the atomic energy program should be assigned the highest priorities to facilitate procurement of the tools and materials required to produce an atomic bomb.[20] Yet, by September, as

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[18] During the war only two shipments of ore, totaling 200 tons, failed to reach the United States—one aboard a vessel torpedoed in late 1942 and the other on a ship that sank as a result of a marine accident in early 1943. See MDH, Bk. 7, Vol. 1, p. 2.5, DASA.

[19] MPC Rpt, 15 Dec 42, MDR.

[20] Except where indicated, discussion of priorities based on MDH, Bk. 1, Vol. 9, "Priorities Program," DASA, with many of the basic documents relating to the priorities problem reproduced in App. A. Ibid., p. 2.5 and App. B1, DASA; Ltr, Weaver (Resources Div Dir, SOS) to Groves, sub: Special Priorities Authority for Dist Engr, 26 Sep 42, copy in ibid., App. A5, DASA; Memo, Marshall to All Area Engrs, sub: Requests for Out-of-line Ratings, 16 Oct 42, copy in ibid., App. A12, DASA; Marshall Diary, 17, 19, 26 Sep and 1 Oct 42, MDR; Memo, Johnson to Groves, sub: Current Events, 30 Sep 42, Admin Files, Gen

Continued

Groves assumed overall administrative leadership of the project, it was evident that the AA-3 base rating Colonel Marshall had secured in July was not going to be adequate to ensure the uninterrupted development of the atomic program. Consequently, following consultation with General Styer, Groves moved immediately to obtain for the project the priority rating he believed was essential for its successful continuation.

Both generals had decided to seek broad authority for the District to issue an AAA priority whenever there was a need to break a bottleneck. When Groves called on WPB Chairman Donald Nelson on 19 September, he had with him the draft of a brief letter—addressed to himself and to be signed by Nelson—in which he had incorporated the idea of assigning the desired AAA authority to the project. As Groves later recalled, Nelson's first reaction was negative; however, when the general threatened to take the matter to the President, the chairman changed his mind. Whether or not other pressure already had been brought to bear on Nelson is not known, but he did agree to sign the letter as Groves had written it.

> I am in full accord [it read] with the prompt delegation of power by the Army and Navy Munitions Board [ANMB] through you to the District Engineer, Manhattan District, to assign an AAA rating, or whatever lesser rating will be sufficient, to those items the delivery of which, in his opinion, cannot otherwise be secured in time for the successful prosecution of the work under his charge.[21]

On 26 September, the ANMB issued the District a blank check to assign the AAA priority. But General Weaver, senior Army representative on the ANMB, warned Groves that use of this AAA authority must not interfere unnecessarily with other high-priority programs and that, with each use of the rating, a written report must be submitted within a 24-hour period. That same day, at his first meeting with the S-1 Executive Committee, Groves explained to the group that the AAA priority would not be used for the entire project, but only when progress would be unduly delayed by employment of any lower rating. And to ensure retention of AAA authority, an AA-3 or lesser priority would be utilized whenever possible. Before adjourning, the conferees agreed that the OSRD would continue to deal with its own priority problems as far as possible, with the Army lending assistance when necessary, and that the Washington Liaison Office of the Manhattan District would handle the general administration and coordination of priorities for all future procurement for the atomic project.

Now that the District had AAA authority as a backup to overcome procurement obstacles, both Groves and

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Corresp. 319.1, MDR; DSM Chronology, 26 Sep 42, Sec 2(e), OROO; Groves, *Now It Can Be Told*, pp. 22-23; MPC Rpt, 15 Dec 42, MDR; Groves, S-1 Ex Committee Mtg (hereafter cited as MPC Min—actual summaries of actions required and decisions reached at MPC meetings), 5 Feb 43, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; Memo, Weaver to Chief of Engrs, sub: Priority Rating for MD, 22 Mar 43, Admin Files, Gen Corresp, 322.011 (LC), MDR; Memo, Denton, ASF, to Chief of Engrs, Attn: Groves, sub: MD, 1 Jul 44, Admin Files, Gen Corresp, 400.1301 (Priority), MDR.

[21] Ltr, Nelson to Groves, 19 Sep 42, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab B, MDR.

Styer believed that development of the atomic program could continue with the AA-3 base rating. By 1943, however, the project's unfolding requirements revealed that for even routine procurement the AA-3 rating was inadequate and the AAA rating unnecessarily high. To remedy this situation, Groves wrote to General Weaver in early February and requested that the District's priority "authority given in [the] letter of September 26, 1942 be amplified to include use of AA-1 and AA-2 ratings." [22] Although the Nelson letter had referred to the use of lesser ratings than AAA whenever these would suffice, the fact that the Joint Chiefs of Staff had forbidden use of AA-1 or AA-2 for construction projects had ruled out their earlier use by the District. Weaver officially responded on 22 March, upgrading the rating of AA-3 to AA-2X—a new priority created to provide supplies and services for urgent foreign and domestic industrial programs.

Groves, however, still was not satisfied and, in the months that followed, continued to press ANMB officials to assign the maximum AA-1 base rating. Time passed, but the general persisted in order to achieve his objective. Finally, on 1 July 1944, the District received AA-1 authority.

Following District policy, the Washington Liaison Office was to use the lowest rating that would bring about the required delivery of materials. But to counter the threat from other urgent wartime programs during the District's massive procurement and construction phase between 1943 and early 1945, the officer assigned emergency priorities at the AAA level for more than $77 million worth of orders. At times, the Manhattan Project was using more AAA ratings than the combined total for all other Army and non-Army programs. Yet, through the exercise of discretion, Groves and his staff were able to avoid not only strong criticism of their actions but also attempts to revoke the District's AAA authority. Groves's success in obtaining the successive advances in the priority status of the Manhattan Project ensured that, despite occasional problems and annoyances, procurement needs for the atomic program were met.

Establishment of Los Alamos

In the late summer of 1942, J. Robert Oppenheimer, the University of California physicist who was directing the theoretical aspects of designing and building an atomic bomb, became convinced a change was needed. Studies under his direction had been going on in various institutions that were equipped for fast-neutron studies. Now Oppenheimer and his associates felt that further progress could be best achieved by concentrating everything in one central laboratory devoted exclusively to this work. Taking this step would not only eliminate waste and duplication, but it would also permit a freer exchange of ideas and provide for the centralized direction of all work, including studies of chemical, engineering, metallurgical, and ordnance problems that so far had received little or no attention.[23]

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[22] Ltr, Groves to Weaver, sub: Out-of-line Ratings, 7 Feb 43, copy in MDH, Bk. 1, Vol. 9, App. 7, DASA.

Groves first met Oppenheimer in early October while on his initial trip to familiarize himself with the atomic programs at the Universities of Chicago and California (Berkeley). The general heard a report from Oppenheimer on the eighth and the two men hit it off at once. Groves was interested in Oppenheimer's proposed central laboratory and, a week later when the two met again with Marshall and Nichols on a Chicago–New York train, Groves asked Oppenheimer to come to Washington, D.C., to explore the idea. There, they talked with Arthur Compton and Vannevar Bush, and on 19 October Groves approved the decision to establish a separate bomb laboratory. Pleased with what had been accomplished and confident that Groves's support in this step would "bear good fruit in the future," Oppenheimer left immediately for Boston to brief Conant at Harvard, where the latter held the post of university president.[24]

Oppenheimer and Compton had spoken of placing the laboratory at the Tennessee site, or possibly in Chicago, but neither they nor General Groves were satisfied with these choices. For this most secret part of the secret Manhattan Project isolation and inaccessibility were most essential, and neither the Clinton Engineer Works nor Chicago offered these. In addition to the obvious requirements of a climate that would permit year-round construction, safety from enemy attack, ready transportation, and access to power, fuel and water, there were several other important considerations. The site would have to provide an adequate testing ground; it should be in a sparsely populated area, for reasons of safety as well as security; the land should be relatively easy to acquire; and it should already have sufficient buildings to house most of what was anticipated would be a comparatively small staff.[25]

Groves briefly considered two other sites. One near Los Angeles, he rejected on security grounds; the other, near the California-Nevada border, on the east side of the Sierra Nevada in the vicinity of Reno, he found unsatisfactory because it was too inaccessible and heavy snows would interfere with winter operations. He agreed with Oppenheimer that the region around Albuquerque, New Mexico, seemed to offer the most attractive possibilities. Oppenheimer owned a ranch in this vicinity, and his general knowledge of the countryside contributed considerably to making an accurate appraisal of the area. Air and rail service to Albuquerque were excellent; the climate was moderate throughout the year;

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[23] Testimony of Oppenheimer in *Oppenheimer Hearing*, pp. 12 and 28; Smyth *Report*, p. 74.

[24] Quotation from Ltr, Oppenheimer to Groves, 19 Oct 42, Admin Files, Gen Corresp, 322 (Los Alamos), MDR. See also Testimony of Oppenheimer in *Oppenheimer Hearing*, p. 28; Nichols, Comments on Draft Hist "Manhattan," Incl to Ltr, Nichols to Chief of Mil Hist, 25 Mar 74, CMH; Marshall Diary, 15–16 Oct 42, MDR; Groves Diary, Oct 42, LRG; Groves, *Now It Can Be Told*, p. 61.

[25] Paragraphs on selection of bomb laboratory site based on Groves, *Now It Can be Told*, pp. 63–67; MDH, Bk. 8, Vol. 1, "General," Sec. 2, DASA; Rpt, U.S. Engrs Office, Albuquerque Dist, sub: Proposed Site for Mil Proj at Los Alamos Ranch School, Otowi, N.Mex., 23 Nov 42, Admin Files, Gen Corresp, 600.03, MDR; Groves Diary, Nov 42, LRG; Testimony of Oppenheimer in *Oppenheimer Hearing*, pp. 12 and 28; Interv, Author with Edwin M. McMillan (Rad Lab, Univ of Calif at Berkeley), 8 Jul 64, CMH.

and the area was not only isolated but also sufficiently far inland from the West Coast to be beyond any serious danger from the by now remote possibility of Japanese interference.

At the end of October, Maj. John H. Dudley, one of Colonel Marshall's assistants who was familiar with the general area, made some preliminary surveys. He recommended a site at Jemez Springs, about 50 miles north of Albuquerque. (*See Map 2.*) Engineers from the Albuquerque District surveyed the site and, on 16 November, Groves met Oppenheimer and several others for a personal inspection of the area. They soon concluded, however, that the Jemez Springs site would not do; the land would be difficult to acquire and the nature of the terrain would prevent later expansion of the installation.[26]

Still hoping to find a suitable location in this general area, Groves and the others drove east and slightly north toward the tiny settlement of Los Alamos. This community, atop a high, level tableland, actually consisted of little more than the Los Alamos Ranch School for Boys. Otherwise the area was virtually uninhabited, with the nearest town located some 16 miles away. The school buildings and the complete isolation of the site were arguments in its favor. There appeared to be sufficient water, if the supply were carefully used, and all other characteristics seemed satisfactory. The only question was how willing the owners of the school would be to give it up to the Army. If they seriously opposed government acquisition, the resultant publicity would run counter to the secrecy desired by the project leaders.

While Groves and Oppenheimer headed back to Washington, D.C., Dudley and engineers of the Albuquerque District began a formal survey of a proposed site at Los Alamos. The desired area consisted of about 54,000 acres in Sandoval County, somewhat more than 20 miles airline distance northwest of Santa Fe, of which all but about 8,000 acres was in national forest land already owned by the United States government. Grazing lands and the Los Alamos Ranch School comprised the rest of the area. Because the school was having some difficulty getting instructors during the war and was in serious financial trouble, the owners were willing to sell. As for the grazing lands, there appeared to be no problem in acquiring them.

Even before the reports of this survey came in, General Groves had called a meeting in Washington to confer about the site with Oppenheimer, as well as with two of his scientific colleagues from California, Ernest Lawrence and Edwin McMillan, and with Arthur Compton. Then, on 23 November, with the reports in hand, Oppenheimer, Lawrence, and McMillan again inspected the area with Major Dudley and made recommendations on possible locations for

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[26] Account of inspection of sites in Los Alamos area based primarily on Groves, *Now It Can Be Told*, pp. 65–67, and Testimony of Oppenheimer in *Oppenheimer Hearing*, p. 28. Another member of the inspection party was Edwin M. McMillan, a physicist on the faculty at the University of California, Berkeley, and a long-time associate of Oppenheimer. As McMillan recalled, he, Oppenheimer, and Dudley had gone on horseback to the Jemez Springs area earlier in the day and then had been joined by Groves in the afternoon. McMillan had been a guest at Oppenheimer's ranch on earlier occasions and was therefore generally familiar with the Los Alamos area. See McMillan Interv, 8 Jul 64, CMH.

APPROACH ROAD TO THE LOS ALAMOS RANCH SCHOOL FOR BOYS

laboratories and housing. "Lawrence was pleased by the site," Oppenheimer reported to Groves, "and so, again, were we." [27]

And so, again, was Groves. Two days later he approved the Los Alamos site and began steps to acquire the land. Right of entry to the heart of the site had already been obtained from the school director and, although the actual legal acquisition would take several months, Groves was able to authorize the Albuquerque District to proceed with construction on 30 November. The whole business was carried out, to use Oppenheimer's words, "with unbelievable dispatch." [28]

As with the Clinton Engineer Works, the Los Alamos site in the beginning also was referred to, for security reasons, as a demolition range—a somewhat ironic reference for a laboratory where an atomic bomb would be built. The site also had several names, the most common being Site Y, Project Y, Zia Project, Santa Fe, or simply, Los Alamos, its official title and the name by which it would be most widely known in the future. [29]

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[27] Ltr, Oppenheimer to Groves, 23 Nov 42, Admin Files, Gen Corresp, 600.1 (Santa Fe), MDR.

[28] Memos, Groves to Albuquerque Dist Engr, sub: Proj Constr at Los Alamos, N.Mex., 30 Nov 42, and Groves to SWD Div Engr, sub: Constr in Vic of Albuquerque, N.Mex., 30 Nov 42, Admin Files, Gen Corresp, 600.1 (Santa Fe), MDR; Ltr, Robins (Act Chief of Engrs) to CG SOS, sub: Acquisition of Land for Demolition Range at Los Alamos, N.Mex., 25 Nov 42, Incl to Memo, O'Brien to Ashbridge, sub: Land Acquisition in Connection with MD, 17 Apr 43, MDR; MDH, Bk. 8, Vol. 1, Secs. 2-3, passim, DASA. Quoted words from Testimony of Oppenheimer in *Oppenheimer Hearing*, p. 28. For detailed account of land acquisition at Los Alamos see Ch. XV.

[29] Memo, Groves to CG SOS, sub: Activation and Administration of Los Alamos, 27 Feb 43, Admin Files, Gen Corresp, 319.2 (Los Alamos), MDR.

Once the choice of Los Alamos had been made, events moved swiftly. "The last months of 1942 and early 1943," recalled Oppenheimer later, "had hardly hours enough to get Los Alamos established."[30] Vigorously supported by Groves, Compton, Conant, and others, Oppenheimer launched an extensive recruitment program. He traveled all over the country, urging scientists of recognized ability to join the new laboratory. Restricted to revealing only what was absolutely necessary about the project, Oppenheimer faced no easy task trying to arouse the interest of scientists, technicians, and mechanics in the program, in indicating its sense of urgency, and in persuading them to sign up for work at a military post in the middle of the New Mexico desert, where they and their families might have to remain isolated for the duration of the war. Nevertheless, he was highly successful in these efforts. Recruits from Princeton, Chicago, California, Minnesota, Wisconsin, and other universities joined the program, the first contingent arriving at Los Alamos with Oppenheimer in March 1943, long before construction at the site was completed.

With the university scientists came their equipment: a cyclotron from Harvard, two more particle accelerators from Wisconsin, another from Illinois. Locating and securing this essential equipment was difficult enough; shipping it to New Mexico was an additional problem. "Everybody," Oppenheimer later recalled, "arrived with truckloads of junk and equipment." Under a contract with the University of California, erection of the first cyclotron began at Los Alamos in mid-April, and the first experiment was performed early in July. Already, Oppenheimer continued, "we were finding out things that nobody knew before."[31]

Los Alamos was officially activated as a military establishment on 1 April 1943, with Oppenheimer as its scientific chief and Col. John M. Harman as its military head. It was unique among Manhattan Project installations in that it was established as a separate organization, directly responsible to General Groves. It came under the district engineer only for routine administrative matters. As its civilian director, Oppenheimer had broad authority and administrative responsibility. In charge of all scientific work as well as "the maintenance of secrecy by the civilian personnel under his control,"[32] he was responsible only to Groves and Conant. This arrangement relieved Compton and the Metallurgical Laboratory of the responsibility for bomb design and construction and left them free to concentrate on plutonium production. The relations between Oppenheimer and Colonel Harman were based on close cooperation, rather than control. Harman, who also reported to Groves, had little or nothing to do with scientific matters. His primary responsibility was to oversee Los

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[30] Testimony of Oppenheimer in *Oppenheimer Hearing*, p. 12. This and following paragraph based on ibid., pp. 12–13 and 28–29; Smyth *Report*, p. 151; Compton, *Atomic Quest*, p. 130.

[31] Quoted words from Testimony of Oppenheimer in *Oppenheimer Hearing*, p. 29. See also Memo, Oppenheimer to Groves, 7 Nov 42, and Styer correspondence with Univs of Ill and Wis, Admin Files, Gen Corresp, 400.12 (Equipment), MDR.

[32] Ltr, Conant and Groves to Oppenheimer, 25 Feb 43, Admin Files, Gen Corresp, 600.12 (Los Alamos), MDR.

Alamos as a military reservation, including those housekeeping and guard functions necessary to support Oppenheimer's program.[33]

The other major element in the administration of Los Alamos was the prime contractor, the University of California. Under a War Department contract, its role was largely to provide business management and technical procurement. For reasons of security, the university had no representative at Los Alamos with authority comparable to that of Oppenhemier or Colonel Harman.

Project leaders wanted to make the work and the living conditions at Los Alamos as attractive as possible; however, for reasons of security and safety, General Groves wished to maintain as much control as he could over the scientists. One idea he favored was to put key civilians in uniform as army officers. This plan seemed attractive to Oppenheimer but aroused strong opposition from many of the other scientists. The Military Policy Committee finally agreed to drop the idea for the period of initial experimental studies, but insisted that the scientific and engineering staff be composed entirely of commissioned officers when final experiments and the construction of the bomb began. Yet, when this time arrived, Project Y had grown so large that the plan was dropped as being impractical and unnecessary.

The most important personnel problem at Los Alamos was choice of a scientific director, and Oppenheimer's appointment was no simple matter. While he had been the leader of the group studying the theoretical aspects of constructing atomic bombs, the Los Alamos program was to be a practical operation, and carrying it out would require considerable administrative and organizational abilities. The chiefs of the three other major Manhattan laboratories—Compton, Lawrence, and Urey—were all Nobel Prize winners. Oppenheimer was not, and there was some feeling among the scientists that this might disqualify him as head of the Los Alamos Laboratory. General Groves, while impressed with Oppenheimer's great intellectual capacity, also was not entirely certain. Bush and Conant shared his hesitation; Lawrence, Compton, and Urey all indicated some reservations.

Nevertheless, a tentative decision in favor of Oppenheimer appears to have been made quite early, because neither Lawrence nor Compton—the only other candidates—could be spared from his own vital project. Oppenheimer's appointment as "Scientific Director of the special laboratory in New Mexico" was formalized on 25 February in a letter to him from Groves and Conant;[34] it did not,

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[33] Except where noted, this and following paragraphs based on ibid.; Memo, Groves to CG SOS, sub: Activation and Administration of Los Alamos, 25 Feb 43, MDR; Testimony of Oppenheimer and Groves in *Oppenheimer Hearing*, pp. 28 and 171–72; Compton, *Atomic Quest*, pp. 129–30; Memo, Marshall to Groves, sub: Major MD Contracts, 27 Apr 43, Admin Files, Gen Corresp, 161, MDR (also see WD–Univ of Calif Contract W–7405–eng–36, 20 Apr 43, LASL); MDH, Bk. 8, Vol. 2, "Technical," pp. I.5–I.6, III.6, App. 7, DASA; MPC Min, 5 Feb 43, MDR. See Ch. XXIII for further discussion of the administrative organization at Los Alamos.

[34] Quotation from Ltr, Conant and Groves to Oppenheimer, 25 Feb 43, MDR. See also Groves, *Now It Can Be Told*, pp. 60–64; Compton, *Atomic Quest*, p. 129; Testimony of Bush in *Oppenheimer Hearing*, pp. 560–61; Ltr, Conant to Groves, 21 Dec 42, Admin Files, Gen Corresp, 334 (Postwar Policy Committee–

Continued

however, become final until mid-July because of security clearance problems. As was well-known to most of the project leaders, Oppenheimer had an extended history of supporting Communist-front organizations and causes and of association with Communists and fellow-travelers. Only through direct action by Groves was Oppenheimer, who was already at work in Los Alamos, finally cleared.[35]

Manhattan Project Organization and Operation

With the establishment of Los Alamos on 1 April 1943, the basic structure of the Army's organization for administering the atomic bomb program was essentially completed. In the months that followed, detailed and sometimes substantial changes were made in that organization.[36] For example, in mid-August, the Manhattan District moved from its temporary location in New York to permanent quarters at Oak Ridge, and Colonel Nichols, the deputy district engineer, replaced Colonel Marshall as district engineer when the Corps of Engineers reassigned Marshall to a post where he might receive his long overdue promotion to the rank of brigadier general.[37] But these subsequent changes in key personnel and in the location of certain elements would not significantly affect the basic structure of the *Manhattan Project*, the term that by mid-1943 most accurately described the Army's overall administrative organization for the atomic bomb program.

The administrative elements that comprised the Manhattan Project

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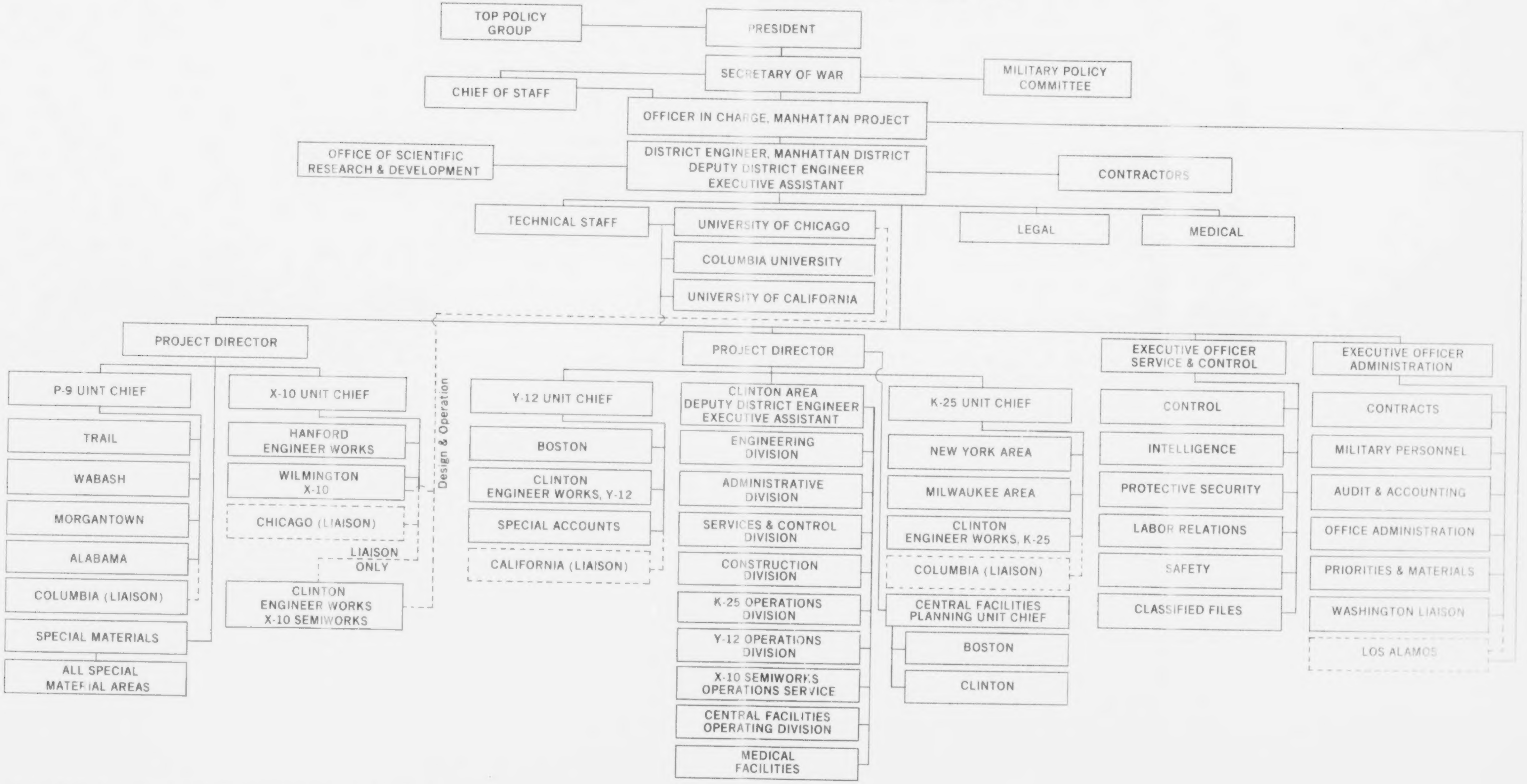
Chicago), MDR; Leslie R. Groves, Comments on Draft Ms "Now It Can Be Told: The Story of the Manhattan Project," LRG; Interv, British writer Hailey with Groves, 13 Dec 57, LRG.

[35] See Ch. XI for full story of the security investigation and clearance of Oppenheimer.

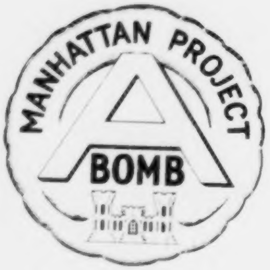
[36] Subsection based on Org Charts, U.S. Engrs Office, MD, 27 Jan, 1 and 30 Apr 43, OROO; Org Charts, U.S. Engrs Office, MD, 15 Aug and 1 Nov 43, 15 Feb, 1 Jun, 28 Aug, and 10 Nov 44, and 26 Jan 45, Admin Files, Gen Corresp, 020 (MED-Org), MDR; Gen Corresp, Dist Engr to MD Subordinates, Sep 42–late 43, OROO [e.g., see Memo, Lt Col Thomas T. Crenshaw (Mat Sec chief) to Dist Engr, sub: Org Chart, 13 Nov 42, and Memo, Lt Col Robert C. Blair (Ex Off, Engr and Opns, MD) to Dist Engr, sub: Proposed Org for Maint and Opn of Gen Facilities, 22 Jan 43]; Interv, Fine and Remington (Hist Div, OCE) with Marshall, 19 Apr 68, CMH; Interv, Stanley L. Falk and Author with Charles Vanden Bulck and Capt W. R. McCauley, 22 Jun 60, CMH; MDH, Bk. 1, Vol. 1, "General," pp. 3.13–3.21, DASA; Groves, *Now It Can Be Told*, pp. 2 and 27–32.

[37] Marshall's new assignment was as commanding officer, Engineer Replacement and Training Center, Camp Sutton, N.C., with the rank of brigadier general. He remained in this assignment only until November 1943, when he went overseas to the Southwest Pacific Area to serve in a variety of positions in Australia, New Guinea, and the Philippines (December 1943 to February 1945). Marshall had first suggested to Groves that he be relieved as district engineer of the Manhattan District at the end of 1942, after realizing that Groves was not going to function simply as a liaison officer in Washington, D.C., but intended to take a very direct and active role in the detailed administration of the District. Marshall later recalled he thought having two senior and experienced engineer officers exercising the command function was unnecessary duplication. Furthermore, Marshall, who was senior to Groves in permanent Regular Army rank, realized his own chances of promotion to general officer rank were remote as long as he remained in a subordinate position under Groves. Groves, however, responded negatively to Marshall's request, stating he felt that he must have an officer of Marshall's experience and capabilities in the key district engineer position. Thus, Marshall resigned himself to serve as district engineer for the duration of the project; however, in August 1943, Groves unexpectedly informed him that his request for relief had been approved. For further details on Marshall's relief and reassignment see Marshall Interv, 19 Apr 68, CMH; Marshall Diary, 19 Sep 42, MDR; and Groves, *Now It Can Be Told*, p. 29. In his account of Marshall's reassignment, Groves errs in stating that Marshall was relieved for an immediate "key assignment overseas," overlooking Marshall's intervening assignment to command Camp Sutton.

Chart 1—Organization of the Manhattan Project, April 1943


TOP POLICY GROUP
PRESIDENT
SECRETARY OF WAR
MILITARY POLICY COMMITTEE
CHIEF OF STAFF
OFFICER IN CHARGE, MANHATTAN PROJECT
OFFICE OF SCIENTIFIC RESEARCH & DEVELOPMENT
DISTRICT ENGINEER, MANHATTAN DISTRICT
DEPUTY DISTRICT ENGINEER
EXECUTIVE ASSISTANT
CONTRACTORS
TECHNICAL STAFF
UNIVERSITY OF CHICAGO
COLUMBIA UNIVERSITY
UNIVERSITY OF CALIFORNIA
LEGAL
MEDICAL
PROJECT DIRECTOR
P-9 UINT CHIEF
TRAIL
WABASH
MORGANTOWN
ALABAMA
COLUMBIA (LIAISON)
SPECIAL MATERIALS
ALL SPECIAL MATERIAL AREAS
X-10 UNIT CHIEF
HANFORD ENGINEER WORKS
WILMINGTON X-10
CHICAGO (LIAISON)
LIAISON ONLY
CLINTON ENGINEER WORKS X-10 SEMIWORKS
Design & Operation
PROJECT DIRECTOR
Y-12 UNIT CHIEF
BOSTON
CLINTON ENGINEER WORKS, Y-12
SPECIAL ACCOUNTS
CALIFORNIA (LIAISON)
CLINTON AREA DEPUTY DISTRICT ENGINEER EXECUTIVE ASSISTANT
ENGINEERING DIVISION
ADMINISTRATIVE DIVISION
SERVICES & CONTROL DIVISION
CONSTRUCTION DIVISION
K-25 OPERATIONS DIVISION
Y-12 OPERATIONS DIVISION
X-10 SEMIWORKS OPERATIONS SERVICE
CENTRAL FACILITIES OPERATING DIVISION
MEDICAL FACILITIES
K-25 UNIT CHIEF
NEW YORK AREA
MILWAUKEE AREA
CLINTON ENGINEER WORKS, K-25
COLUMBIA (LIAISON)
CENTRAL FACILITIES PLANNING UNIT CHIEF
BOSTON
CLINTON
EXECUTIVE OFFICER SERVICE & CONTROL
CONTROL
INTELLIGENCE
PROTECTIVE SECURITY
LABOR RELATIONS
SAFETY
CLASSIFIED FILES
EXECUTIVE OFFICER ADMINISTRATION
CONTRACTS
MILITARY PERSONNEL
AUDIT & ACCOUNTING
OFFICE ADMINISTRATION
PRIORITIES & MATERIALS
WASHINGTON LIAISON
LOS ALAMOS

Sources: MDH, Bk. 1, Vol. 12, App. C21. DASA; Org Charts, U.S. Engrs Office, MD, 27 Jan and 1 Apr 43, OROO.



Manhattan Project Emblem
(*unofficial, circa 1946*)

were divided into two major categories: those that functioned as integral elements of the Manhattan District and those that operated outside the structure of the District, mostly in the area of high-level policymaking or in the executive direction of the atomic project *(Chart 1)*. The central element in the high-level administrative hierarchy of the Manhattan Project was General Groves's personal headquarters. The headquarters organization consisted of only a very small group: Groves; Mrs. Jean O'Leary, his secretary who served as his administrative assistant in lieu of an executive officer; and several clerical employees.[38] Shortly after becoming Manhattan commander, and knowing from experience that any effort on his part to expedite important project activities would require access or negotiations with government agencies and officials, Groves decided to locate his personal headquarters in rooms adjacent to those already occupied by the Manhattan District's Washington Liaison Office in the New War Department Building on Virginia Avenue, a few blocks from the White House. Considered at first to be temporary, time proved that location especially well suited to the project's need, and Groves's office remained there for the duration of the Army's administration of the atomic bomb program.

When Groves replaced Marshall as the Army's project director, the Engineers chief pointedly removed himself from any further administrative responsibility for the program. Although the Corps of Engineers continued to assist the project, the latter functioned as a basically independent organization, with the Manhattan commander having responsibility to the Army Chief of Staff and Secretary of War and through them to the President.

Committees continued to play an important role in guiding, advising, and instructing the Army administrators of the project and, to some extent, limiting their authority. Beginning in late 1942, the group most involved in providing guidance for the day-to-day administration was the Military Policy Committee, which derived its authority for policymaking from the Top Policy Group. Although the group never formally convened, it continued, as during the OSRD period, to review and ratify all major policies and decisions relating to development and employment of atomic energy for military purposes in World War II. The OSRD S-1 Executive Committee also continued to function as an advisory group until the transfer of most atomic activities from the

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[38] Through most of the war, the headquarters organization remained small. Then in 1945, in anticipation of employment of atomic bombs against Japan, Groves enlarged it to include a public information group.

Mrs. Jean O'Leary Reviewing Project Reports With General Groves

OSRD to the Army was completed in mid-1943.[39]

Responsibility for execution of the plans, policies, and decisions made by the various advisory groups of the Manhattan Project devolved first upon General Groves and through him upon the Manhattan District. Groves, as officer in charge of the atomic bomb program for the Army, exercised command authority over the District, but he was not its chief executive officer. That position was held by the district engineer, who reported to Groves.

The district engineer presided over an organization that was, as it emerged in mid-1943, similar in many respects to the engineer districts that had been formed by the Corps of Engineers in the past to carry out special assignments *(Chart 2)*. Its administrative elements were grouped into two major categories: operating units, which were involved primarily in the day-to-day monitoring of contractor operations; and staff units, which were engaged in overseeing and pro-

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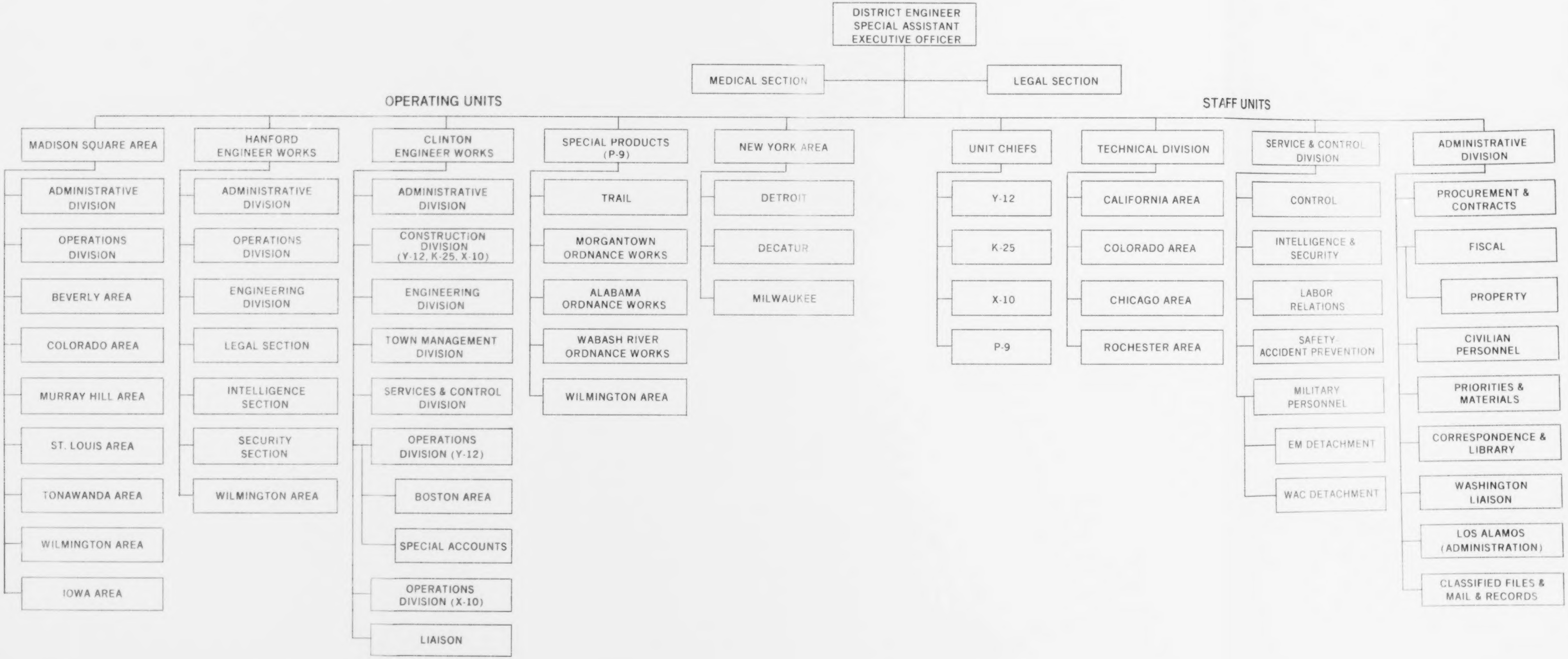
[39] Subsequently, three other advisory groups contributed significantly to administration of the project. These were the Combined Policy Committee (CPC), formed in late 1943, which was concerned with collaboration and exchanges of information on atomic matters with the British and Canadian governments; the Combined Development Trust (CDT), established in June 1944, which was involved in the international aspects of procurement, supply, and control of uranium and thorium ores; and the Interim Committee (IC), organized in May 1945 by the Secretary of War with approval of the President to advise on postwar control of atomic energy at home and abroad, on release of information to the public, and on employment of the bomb against Japan. See Ch. X for a detailed discussion on the establishment and work of the CPC, Ch. XIII on the CDT, and Ch. XXVI on the IC.

Chart 2—Organization of the Manhattan District, August 1943


DISTRICT ENGINEER
SPECIAL ASSISTANT
EXECUTIVE OFFICER
MEDICAL SECTION
LEGAL SECTION
OPERATING UNITS
STAFF UNITS
MADISON SQUARE AREA
ADMINISTRATIVE DIVISION
OPERATIONS DIVISION
BEVERLY AREA
COLORADO AREA
MURRAY HILL AREA
ST. LOUIS AREA
TONAWANDA AREA
WILMINGTON AREA
IOWA AREA
HANFORD ENGINEER WORKS
ADMINISTRATIVE DIVISION
OPERATIONS DIVISION
ENGINEERING DIVISION
LEGAL SECTION
INTELLIGENCE SECTION
SECURITY SECTION
WILMINGTON AREA
CLINTON ENGINEER WORKS
ADMINISTRATIVE DIVISION
CONSTRUCTION DIVISION (Y-12, K-25, X-10)
ENGINEERING DIVISION
TOWN MANAGEMENT DIVISION
SERVICES & CONTROL DIVISION
OPERATIONS DIVISION (Y-12)
BOSTON AREA
SPECIAL ACCOUNTS
OPERATIONS DIVISION (X-10)
LIAISON
SPECIAL PRODUCTS (P-9)
TRAIL
MORGANTOWN ORDNANCE WORKS
ALABAMA ORDNANCE WORKS
WABASH RIVER ORDNANCE WORKS
WILMINGTON AREA
NEW YORK AREA
DETROIT
DECATUR
MILWAUKEE
UNIT CHIEFS
Y-12
K-25
X-10
P-9
TECHNICAL DIVISION
CALIFORNIA AREA
COLORADO AREA
CHICAGO AREA
ROCHESTER AREA
SERVICE & CONTROL DIVISION
CONTROL
INTELLIGENCE & SECURITY
LABOR RELATIONS
SAFETY-ACCIDENT PREVENTION
MILITARY PERSONNEL
EM DETACHMENT
WAC DETACHMENT
ADMINISTRATIVE DIVISION
PROCUREMENT & CONTRACTS
FISCAL
PROPERTY
CIVILIAN PERSONNEL
PRIORITIES & MATERIALS
CORRESPONDENCE & LIBRARY
WASHINGTON LIAISON
LOS ALAMOS (ADMINISTRATION)
CLASSIFIED FILES & MAIL & RECORDS

Source: Org Chart, U.S. Engrs Office, MD, 15 Aug 43, Admin Files, Gen Corresp, 020 (MED-Org), MDR.

viding services. In both types of units, military personnel headed virtually all administrative elements down to the section level, although many of the District employees filling positions that required special knowledge or training were civil service workers. The chiefs of each of these units reported directly to the district engineer, who functioned with the assistance of a small headquarters group comprised of an executive officer, two administrative assistants, and legal and medical advisers.

Operating units, each headed by a unit chief or an area engineer, were formed to monitor each of the major contractor-operated activities. The number and precise character of these operating units varied considerably due to the quantity and type of contract operations under District supervision. Thus, in the early period of the District's operation the units conformed to the emphasis on construction activities, whereas later they reflected the shift to plant-operating activities. By the time of the District headquarters move in August 1943 from New York City to Oak Ridge, five major operating units—Madison Square Area, Hanford Engineer Works, Clinton Engineer Works, New York Area, and Special Products—had been established.

The elements concerned with overseeing project operations and services were divided among seven major staff components: the Y-12 (electromagnetic), K-25 (gaseous diffusion), X-10 (plutonium), and P-9 (heavy water) unit chiefs; and the Technical, Service and Control, and Administrative Divisions. The four unit chiefs were responsible for the overall supervision of the construction and operations phases of the production processes. The Technical Division had responsibility for the major contractor-operated research and development programs at Columbia and the Universities of California (Berkeley), Chicago, and Rochester;[40] the Service and Control Division, for control functions, intelligence and security matters, labor relations, safety, and military personnel; and the Administrative Division, for procurement and contracts, fiscal matters, civilian personnel, priorities and materials, correspondence and the library, classified files and mail and records, and the District's Washington Liaison Office. Additionally, the latter division provided the Los Alamos Laboratory with specified routine services.

With the rounding out of the Army's organization for administration of the American atomic energy program in mid-1943, General Groves and his District staff were in a much firmer position to convert the OSRD-inherited research and development organization into an industrial complex for producing fissionable materials for atomic weapons. During the months that followed, the Army had to make further internal reorganizations to meet the new requirements resulting from the shift from plant construction to plant-operating activities and the addition of new facilities.[41] But with Groves at the helm,

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[40] In early 1943, Groves selected Professor Stafford L. Warren of the University of Rochester to direct a medical research program on the effects of radiation. See Ch. XX.

[41] While from mid-1943 until the end of World War II the basic pattern of the Manhattan District's administrative organization remained relatively fixed, the district engineer in 1944 established new

Continued

carrying out the Military Policy Committee's decisions and overcoming seemingly insurmountable obstacles, the atomic project moved ahead.

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operating units for specific functions—for example, to administer divisions charged with supervising operation of community and site facilities in Tennessee, to supervise construction and operation of the third major production plant (thermal diffusion), and to expedite production in all of the project's major plants. He also abolished the staff unit's Service and Control and Technical Divisions, placing part of their functions in the Administrative Division (for example, labor relations) and shifting the rest into special staff elements that reported directly to him. Thus, by late 1944, the special staff included control, research control, safety, and historical record sections, medical and naval detachment elements, a public relations and special services office, a legal adviser, a district inspector, and a special assignments officer (cover designation for officer responsible for liaison with Canadian atomic program officials). Not on the special staff but functioning as units in the District headquarters were intelligence and security, patents, fire protection, and liaison elements in Washington, D.C.

PART TWO

PRODUCING FISSIONABLE MATERIALS

CHAPTER V

Organizing for Production

In June 1942, the Army took its first step to form a production organization for the manufacture of fissionable materials with negotiation of an AEM (architect-engineer-manager) agreement with the Stone and Webster Engineering Corporation of Boston; however, as the complexity of the AEM job became evident in the following months, attempts were made to involve a number of other leading American industrial and construction firms. The Army's task of getting the skilled manpower and technical know-how required to produce fissionable materials in quantities sufficient to fabricate atomic weapons was not easy. It was complicated greatly by the absolute necessity for speed, which meant that contracts had to be let before the customary preliminary plans and technical data were available. This lack of specific information—blueprints, specifications, and similar data—was an added handicap because many of the scientific and technical processes involved were virtually unknown in industrial circles. Also, because many industrial organizations already had committed most of their resources to war production, the managers and engineers of these organizations were reluctant to take on additional responsibilities for a project of such unusual and uncertain character. The Army therefore was faced with the problem of somehow convincing them that the success of the program was so crucial to the outcome of the war they simply could not refuse to participate.

Plutonium Project

The question of who should have responsibility for carrying through the plutonium program to the production stage had been a matter of controversy for some time at the Metallurgical Laboratory.[1] Some of the scientists had proposed that they themselves direct the design, development and engineering, and construction of the plutonium plant. Metallurgical Laboratory Director Arthur Compton, who early in his career had worked as an employee and consultant for large electrical companies, knew that this proposal ran counter to the procedure customarily followed in American industry, namely, the assigning of research, development, and production to separate departments—a practice that experience had shown generally brought the most efficient results. He suggested that time would be saved by securing an experienced industrial firm already accustomed to carrying out large-scale projects, leaving the research to the Metallurgical Laboratory staff.

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[1] Paragraphs on the Metallurgical Laboratory based on Compton, *Atomic Quest*, pp. 108-10; Groves, *Now It Can Be Told*, pp. 44-46; DSM Chronology, 25 Jun 42, Sec. 2(e), OROO; Hewlett and Anderson, *New World*, p. 184.

The staff's reaction, he recalled later, "was a near rebellion." [2] The younger scientists pointed out that they had demonstrated their ability to supervise development of processes to the stage of large-scale production by the success they had so recently achieved in increasing the output of pure uranium metal and graphite. After having contributed so much to its initiation and development, they wanted to see the plutonium program through to final fulfillment. And solidly backing them were those laboratory scientists who had been born and educated in Europe. Most of them were inclined to suspect the motives of large industrial firms. Also, most had a more extensive knowledge of engineering techniques than their American counterparts learned as a regular part of their scientific training.

By early summer of 1942, progress in research required that a decision soon be reached. Compton assembled some seventy-five members of his research and administrative staff to agree on a plan of organization. It soon became apparent they were not going to reach a consensus, so Compton announced he would proceed without their approval. At the OSRD S–1 Executive Committee meeting of 25 June, Compton supported the decision to assign AEM responsibility for the plutonium as well as the other processes to Stone and Webster.

Although the S–1 Committee had suggested that the University of Chicago might operate the pilot facility to be built in the Argonne Forest area southwest of the city, no action had yet been taken. In mid-August, Compton urged Colonel Marshall that an operator should be selected promptly as construction of this unit was about to begin. He also pointed out that the operator of the Argonne chemical facility probably would have responsibility for the separation works of the main plutonium plant; therefore, the operator's engineering and design personnel should have an opportunity to observe construction of the plant at Argonne.

As possible operators, Compton recommended that Marshall approach E. I. du Pont de Nemours Company, Standard Oil Development Company, or Union Carbide and Carbon Corporation. For reasons of security, Marshall wanted to hold to a minimum the number of firms to be brought in to build and operate project facilities. He proposed that for the time being Stone and Webster add operation of the Argonne separation plant to its other responsibilities. Both Compton and the engineering firm promptly accepted this arrangement—the latter, however, with a proviso that it be permitted to secure technical assistance from other organizations.

At the Bohemian Grove meeting in early September, the S–1 Committee recommended that Stone and Webster get the technical assistance it required. General Groves, newly appointed as Manhattan commander, and Stone and Webster agreed on

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[2] Compton, *Atomic Quest*, p. 109.

26 September that Du Pont should be approached and the S-1 Committee accepted their decision. Two weeks later, Du Pont assented to design and procure not only the chemical separation equipment but also part of the pile equipment for the plutonium pilot plant. At first Du Pont had resisted taking on any responsibility for the piles, pleading lack of experience and strain on its facilities as a result of its other government projects. But Groves and Compton finally persuaded the company that this was the logical solution to a difficult problem.[3]

Because Du Pont's contract covered only design and procurement of equipment and because Stone and Webster would operate only the Argonne separation installation, the most important plutonium production problem—securing an operator for the other pilot facilities and the production plant—remained to be solved. Both Groves and Compton were moving rapidly toward the view that the size and complexity of this task required the selection of a company other than Stone and Webster. The Manhattan chief paid his first visit to the Metallurgical Laboratory in early October 1942. Reviewing the plutonium program with Compton and his senior staff, Groves quickly concluded that to bring this process into production was going to be a far greater project than anyone had anticipated. After further consultation, Groves and Compton decided that Stone and Webster should be relieved of all responsibility for the plutonium project, a decision concurred in by both Vannevar Bush and James B. Conant.[4]

As General Groves learned more about the plutonium process, he also came to the conclusion that it would be preferable to turn the entire project of design, engineering, construction, and operation over to a single firm. If the proper organization were chosen, the gain in efficiency of operation would ease his own task of coordination. One Du Pont policy, in particular, impressed Groves. Unlike most American industrial firms, the company had a long-established practice of building its own plants. Hence, Du Pont had the resources and experience necessary to carry out all aspects of the plutonium production plant, an advantage from the standpoint of both security and speed of getting into production.

When Groves proposed to Compton, Bush, Conant, and other leaders that Du Pont be asked to assume sole responsibility for the plutonium production project, replacing Stone and Webster, he received a generally favorable response. But the Manhattan chief was fully aware that several key members of the Metallurgical Laboratory, with whom Du Pont engineers would have to work quite closely, remained unreconciled to any course that would take plutonium production out of their hands. Furthermore, some members of this dissatisfied group would be especially upset over the selection of Du Pont, which in many ways seemed to them to epitomize big industry.

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[3] Marshall Diary, 14, 18, 26 Sep and 2, 9 Oct 42, OCG Files, Gen Corresp, Groves Files, Misc Recs Sec, behind Fldr 5, MDR; DSM Chronology, 14–15 Aug 42, Sec. 16, 13 Sep 42, Sec. 2(e), and 26 Sep 42, Sec. 15(b), OROO; Ms, Leslie R. Groves, "Now It Can Be Told: The Story of the Manhattan Project" (hereafter cited as Groves Ms), pp. 95–96, CMH.

[4] Account of negotiations with Du Pont drawn primarily from Groves, *Now It Can Be Told*, pp. 46–52; Memo, sub: Prelim Negotiations . . . Between United States of America and Du Pont . . . , Incl to Ltr, R. E. DeRight (Du Pont) to Groves, 30 Oct 43, OCG Files, Gen Corresp, MP Files, Fldr 2F, MDR; DSM Chronology, 10 Nov 42, Sec. 23(b), OROO.

Groves, nevertheless, decided to take immediate steps to negotiate an agreement with Du Pont. On 30 October, he invited Willis Harrington, senior vice president of the firm, to meet with him and Conant, who himself once had served as a consultant to Du Pont. Harrington came the next day, accompanied by chemist Charles Stine, also a vice president of Du Pont and a friend of Conant. Groves and Conant gave the two Du Pont executives data on the pile program and general information about the other processes and the military objectives of the project, emphasizing the urgency of the program and frankly admitting there were serious questions as to its feasibility.

Harrington and Stine were appalled at the idea that their company should assume major responsibility for this phase of the atomic program. As they perceived it, the technical requirements were formidable, the operating conditions unorthodox, and the scientific field one in which Du Pont had no special experience and competence. Faced, however, with Groves's insistence that Du Pont was the only industrial organization in America with the capacity to build the plutonium plant, they reluctantly indicated the company might be able to do the job. But a final decision could only be made by Du Pont President Walter S. Carpenter, Jr., and other members of the firm's executive committee following an investigation by company chemists and engineers. Consequently, a day or two later, Groves granted the company permission to send a team of experts to the Metallurgical Laboratory to see the work in progress.

On 10 November, General Groves, Colonel Nichols, the deputy district engineer, Arthur Compton, and Norman Hilberry, who was associate director of the Metallurgical Laboratory, went to Wilmington, Delaware, to plead further for Du Pont's assistance. Groves emphasized to Carpenter that the project was of utmost importance to the war effort, adding that President Roosevelt, Secretary of War Stimson, and Chief of Staff Marshall also shared this opinion. Furthermore, he continued, there was reason to believe the Axis states might soon be producing fissionable materials in quantities sufficient to manufacture atomic weapons. The only known defense against such weapons was "fear of their counter-employment." [5] If the United States could develop such weapons before the enemy, it could materially shorten the war and potentially reduce American casualties by the tens of thousands.

Following his conference with Carpenter, Groves went to a meeting of the Du Pont executive committee. There, he was joined by Nichols, Compton, and Hilberry. With Carpenter presiding at the meeting, Groves repeated what he had said earlier to the Du Pont president. Some committee members expressed reservations, many of them traceable to the report of the team of company chemists and engineers who had just returned from a visit to the Metallurgical Laboratory. The team had reported that the laboratory scientists had neither demonstrated a self-sustaining chain reaction nor furnished adequate information concerning the basic problem of controlling and removing the tremendous amount of heat that would be generated in a pile operation. And though they were at work on three different pile designs, none—at least when judged in terms of practical engineering—seemed likely to provide a prototype for a large-scale production pile. Progress on the plutonium separation process did not appear much more encouraging. The scientists had yet to demonstrate a method that would separate more than microscopic amounts of plutonium from radioactive fission products. On the basis of its observations, the Du Pont team estimated that only minute amounts of plutonium could be produced in 1943, not much more in 1944, and only enough, possibly, in 1945 to fulfill the planned rate of production for weapon purposes.

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[5] Groves, *Now It Can Be Told*, p. 49.

The pessimistic tone of the Du Pont executive committee's evaluation was not surprising; they concluded, nevertheless, that the pile method was probably feasible. To be certain of this, however, they felt Du Pont must have control over all aspects of the project. Furthermore, the government should guarantee the company against loss from the obviously great hazards inherent in the process. Carpenter informed General Groves on 12 November that Du Pont would take the job, and the Manhattan commander immediately directed Colonel Nichols to draft the terms of a contract.

With Du Pont's participation apparently assured, the Military Policy Committee cautiously endorsed going ahead with plans to build a plutonium plant capable of producing 1.0 kilogram of fissionable material per day. It also directed that Du Pont take over from Stone and Webster at Chicago, relieving the Boston firm of virtually all of its AEM responsibilities for plutonium project activities.[6]

Hardly had that question been settled when important new data cast serious doubt on the explosive characteristics of plutonium. Wallace A. Akers, technical chief of the British Directorate of Tube Alloys (corresponding to the S-1 Executive Committee), was in Washington, D.C., on 14 November to discuss information exchange with Conant. During a luncheon conversation, Akers revealed that British atomic scientists had discovered that plutonium had premature fissioning tendencies that might make it unsuitable for use in a weapon. Greatly disturbed, Conant checked with Ernest Lawrence and Arthur Compton. When they told him that both Oppenheimer and Glenn Seaborg, a chemist who had done extensive research on plutonium at the University of California, Berkeley, expressed some concern about the possibility of obtaining material of sufficient purity to ensure the fissioning qualities in a weapon, Conant got in touch with General Groves. The Manhattan chief responded immediately by setting up an investigating team composed of Lawrence, Compton, and Oppenheimer, as well as physicist Edwin McMillan.[7]

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[6] MPC Min, 12 Nov 42, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR.

On 18 November the four scientists reported back to Groves in optimistic terms.[8] Basing their recommendations on the conclusion that despite "many difficult but solvable problems it should be possible to produce a satisfactory bomb . . . from 49 [plutonium] probably during 1945," they urged maximum speed in building a plutonium production plant. The scientists supported their recommendations with Oppenheimer's estimate of the degree of plutonium purity required for a bomb.

Instead of convincing Conant and Du Pont of the feasibility of plutonium, Oppenheimer's data had the opposite effect. By chance, the Harvard University president had just received figures on plutonium purity requirements from British scientist Sir James Chadwick, and when he compared these with Oppenheimer's, he was shocked to find that the latter's estimates allowed for a degree of impurity ten times as great. This discrepancy was so large that Conant momentarily suspected American scientists had erred seriously in their calculations. Not until he received additional data and written assurances from Compton and Lawrence was his confidence in the feasibility of plutonium fully restored.[9]

As for Du Pont's engineers, Oppenheimer's estimate appeared so exacting that it would be unattainable in any reasonable period of time. In Groves's office on 18 November, Charles Stine and Crawford H. Greenewalt, a chemical engineer serving as chemical director of Du Pont's Grasselli Chemicals Department, complained with some feeling that the Manhattan commander was asking the firm to undertake the most difficult and unpromising of the processes for producing fissionable materials and suggested the company might be better qualified to carry out one of the other processes. Greenewalt's lack of enthusiasm at this juncture can be traced to his pessimistic interpretation of some information he had received a short time before, leading him to conclude that there was only about a 60-percent chance that a sustained chain reaction would be achieved.[10]

Compton, who was also present, was shocked by Stine's assertion that the odds were 100 to 1 against achieving plutonium production in time to be of any value to the war effort. For the Metallurgical Laboratory chief this marked the beginning of a gradual disillusionment with Du Pont. By the end of December he would be seriously suggesting that some other firm be brought in to build the production plants. Compton later recalled that he "probably took Stine's words much more seriously than they were intended." Nevertheless, under those immediate circumstances, he felt that he could not "have drawn such a conclusion without considering the task a waste effort as far as the present war was concerned." Therefore, Compton determined immediately to try to change "their [Du Pont's] point of view to one of optimism." [11]

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[7] DSM Chronology, 14 Nov 42, Sec. 2(a), and 19 Nov 42, Sec. 23, OROO; Hewlett and Anderson, *New World*, pp. 109–10. See Ch. X for details on problems with information interchange between the British and American atomic programs.

[8] Team's report in Memo (for File), Lawrence, Compton, Oppenheimer, and McMillan, 18 Nov 42, Admin Files, Gen Corresp, 401.1–410.2 (Materials), MDR.

[9] Hewlett and Anderson, *New World*, pp. 109–10; Ltr, Lawrence to Conant, 23 Nov 42, Admin Files, Gen Corresp, 201 (Conant), MDR; Ltr, Compton to Conant, 8 Dec 42, Admin Files, Gen Corresp, 319.1, MDR.

[10] Groves, *Now It Can Be Told*, p. 52; Ltr, Lawrence to Conant, 23 Nov 42, MDR; Compton, *Atomic Quest*, pp. 132–34. Du Pont purchased the Grasselli Chemical Company of Cleveland in 1928 and incorporated it as a separate department in the firm.

Reassessment of Processes To Produce a Bomb

At the meeting on 10 November, the Du Pont executive committee suggested that a reappraisal of all aspects of the project would help the company in determining the precise role it should play in the atomic energy program. Seeing the logic of this suggestion, Groves and Conant thought the time was appropriate for a reassessment because project emphasis was shifting from research and development in scientific principles to practical application on an industrial scale. Furthermore, the Military Policy Committee shortly was going to have to prepare a progress report to the President on the project. [12]

Lewis Reviewing Committee

Groves acted promptly to implement reassessment of the project. On 18 November, following close consultation with Conant, he appointed a five-man reviewing committee, headed by Warren K. Lewis, a highly respected professor of chemical engineering at Massachusetts Institute of Technology (MIT). Groves made certain that Du Pont was well represented on the committee, appointing Crawford H. Greenewalt, who had been a student under Lewis at MIT and was an expert on research; Tom C. Gary, manager of the Design Division in the Engineering Department and a specialist in construction; and Roger Williams, chemical director of the Ammonia Department, who was an expert on plant operations. The fifth member, Eger V. Murphree of Standard Oil Development Company and former head of the OSRD S–1 Section's planning board, became ill at the last minute and was unable to participate in the committee's activities. [13]

The committee's mission was to review the entire project from a manufacturing standpoint. To accomplish this, committee members would visit Harold Urey's project at Columbia University, investigate Arthur Compton's research on the pile process at the Metallurgical Laboratory, and assess Ernest Lawrence's work on the electromagnetic process at the Radiation Laboratory. They would not evaluate the centrifuge method. The consensus was that this process was unlikely to produce U-235 in sufficient quantities to be of use during the war. The Military Policy and S–1 Executive Committees agreed that all work, including that on a pilot plant, should be reduced to the minimum necessary to establish the feasibility of the method. Although some support for the centrifuge process still persisted, in time it would be dropped as a major method for producing fissionable material for the bomb.

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[11] Quotations from Compton, *Atomic Quest*, p. 134. See also ibid., pp. 132–33, and Groves, *Now It Can Be Told*, pp. 55–57.

[12] MPC Min, 12 Nov 42, MDR; MPC Rpt, 15 Dec 42, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab B, MDR.

[13] DSM Chronology, 19 Nov 42, Sec. 23, OROO; Groves Diary, 18, 19, 21 Nov 42, LRG; Groves, *Now It Can Be Told*, p. 52; Compton, *Atomic Quest*, pp. 134–35.

After conferring briefly with Groves and Conant in Washington, D.C., on 21 November, the Lewis reviewing committee began its tour in New York. There, committee members met with leaders of the gaseous diffusion project and inspected the experimental equipment in the laboratories at Columbia University, as well as conferred with respresentatives of the M. W. Kellogg Company which had been assigned work on the diffusion process. Leaving New York by train, the committee reached Chicago on the twenty-sixth, Thanksgiving Day.[14]

Compton had first heard about the committee's impending visit on the nineteenth. Sensing that the occasion would afford him the chance to convince Du Pont and the leaders of the Manhattan Project that plutonium could be produced in quantity, and also that the rest of the atomic program was feasible and of great importance for the war, he and his scientific staff immediately had directed all possible resources into a twofold effort: completing as soon as possible the chain reaction experiment under way since October, and preparing a report to demonstrate conclusively the feasibility of the plutonium project.[15]

Unfortunately the experiment was still in progress when the committee arrived, but a hundred-page feasibility report was ready for study. This carefully organized and documented report presented a most optimistic estimate of the situation. Plutonium could be produced in one or more of several types of chain-reacting piles, of which a uranium-graphite system cooled with helium, preferably, or with ordinary pure water seemed to offer the most practical solution. Also, chemical extraction of plutonium in a sufficiently pure state to be used successfully in a bomb was feasible. Moreover, this bomb would probably be more effective than previous estimate had indicated. Provided the plutonium project received adequate support, the goal to produce sufficient fissionable material in 1944 and to attain the production stage in 1945 should be possible. Report in hand, the committee left for Berkeley Thanksgiving evening.[16]

Achievement of the Chain Reaction

The Lewis reviewing commitee returned from the West Coast via Chicago on 2 December. Stopping over between trains, they consulted further with the Metallurgical Laboratory staff. "I'm sorry," Compton explained, "but Enrico Fermi has an important experiment in hand in the laboratory and has asked to be excused."[17]

The "important experiment" was, of course, the continuing attempt to achieve a controlled chain reaction in the experimental pile then under construction at the Metallurgical Laboratory. In October, after laboratory scientists had accumulated a sufficient amount of uranium metal and graphite of requisite purity, two alternating teams began piling graphite blocks intermixed with lumps of uranium in a carefully devised pattern atop a timber framework on the floor of a squash court under the West Stands of Stagg Field, the University of Chicago football stadium. When news of this ongoing experiment reached Groves and Conant during the 14 November S-1 meeting, both men expressed great alarm; however, buttressed with evidence from several tests carried out while the pile was under construction and supported by the senior scientists on his staff, Compton assured Groves and Conant that the experiment posed no great hazard to the heavily populated area adjacent to the university. Although Groves decided not to interfere, he nevertheless alerted the area engineer at the Metallurgical Laboratory to inform him immediately of any signs or developments that indicated the Chicago scientists were underestimating the element of danger.[18]

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[14] MPC Min, 12 Nov 42, MDR; DSM Chronology, 14 Nov 42, Sec. 2(f), and 19 Nov 42, Sec. 23, OROO.

[15] Compton, *Atomic Quest*, p. 135.

[16] Ibid., pp. 135-36; Rpt, Compton, sub: Feasibility of "49" Proj, 26 Nov 42, OSRD; Smyth *Report*, Ch. 6, especially pp. 64-65 and 74-76. Smyth based this chapter largely on the feasibility report.

[17] Compton, *Atomic Quest*, p. 140.

Based on the results of earlier experiments, the scientists constructing the pile knew that when it reached a certain size it would become critical, thus initiating what was hoped would be a self-sustaining chain reaction. To prevent the possibility of premature fission and also to be able to control the reaction once it began, the scientists inserted several neutron-absorbing cadmium strips as control rods. Removal of these control rods would release the flow of neutrons in the lumps of uranium and permit the chain reaction to begin; their reinsertion would halt the process. Various measuring instruments also were attached to or placed in the pile, and the whole setup was watched over by Fermi and his colleagues with all the care and nervous intensity that so unique and critical an experiment inspired.

Late in the afternoon of 1 December, Fermi's crew placed the last lump of uranium and layer of graphite blocks on the pile, by now a massive structure, essentially square in shape and solid-appearing from the floor up to about two-thirds of its height, and from that point to its top near the high ceiling, a series of setbacks.

On the morning of 2 December, the entire experimental group assembled for the crucial test. Most of those present were on the balcony of the court, either as observers or operators of the instrument control cabinet located there. Norman Hilberry, equipped with an axe, was prepared to sever a rope tied to the balcony rail, which would drop into place an emergency safety rod suspended over the pile. A young scientist from the laboratory staff, George Weil, remained on the floor of the court to handle the final control rod. On a platform above the pile, three men stood ready to flood it with a cadmium salt solution, which would absorb sufficient neutrons to halt a runaway reaction if the pile's other control mechanisms should fail. A hundred feet away, behind two concrete walls, another group monitored the test by means of instruments and an intercommunication system. Should anything go wrong on the squash court, incapacitating the group there, the "remote control" men could throw a switch to activate electrically operated safety rods and halt the chain reaction.

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[18] Groves, *Now It Can Be Told*, pp. 53–54.

In midmorning, Fermi sent word to Compton that the test was about to begin and the Metallurgical Laboratory chief, accompanied by Crawford Greenewalt, whom he had selected as the representative of the Lewis reviewing committee, hastened from nearby Eckhart Hall to the stadium. As they arrived, Fermi was testing the pile systematically. As Weil slowly withdrew the final control rod, Fermi carefully checked the recording instruments. With each foot the rod was pulled out, the pile came closer to criticality, and the instruments measuring the neutron activity clicked faster. By about 11:30 A.M. the growing tension among the scientists in the squash court had become obvious. "I'm hungry," said Fermi, suddenly breaking the spell. "Let's go to lunch."

Shortly after 2:00 P.M. the tests were resumed. Faster and faster clicked the neutron counters as the control rod was slowly withdrawn. At about 3:25, Weil moved the rod another foot. Fermi made a rapid computation with his slide rule and, turning to Compton, exclaimed: "This is going to do it." As the neutron count ran faster, it was obvious Fermi was right. The rate of rise of the count was now constant. "The reaction is self-sustaining," announced Fermi, meaning that the slow fissioning of uranium atoms in the pile would continue to produce enough neutrons to keep the process going.

After nearly half an hour of operation, when the radiation around the pile began to rise to dangerous levels, Fermi ordered the control rods reinserted. The world's first self-sustaining nuclear reaction had been initiated, allowed to run, and then stopped. Man had accomplished the controlled release of atomic energy.[19]

Lewis Reviewing Committee Report

While practical demonstration of a chain reaction did much to relieve the hesitancy of Du Pont, the company's management was perhaps even more encouraged by the report of the Lewis reviewing committee, submitted on 4 December. On the premise that "production must be substantially 25 kilos of '25' [U-235] or 15 kilos of '49' [plutonium] per month," the committee felt that the diffusion process had the best chance of producing enough fissionable material of the desired quality and, equally important, that it would probably be the first to attain full-scale production. They agreed that the electromagnetic process was probably the most immediately feasible of all methods under consideration, but it seemed least likely to produce U-235 in the quantity that would be needed. Despite problems, the pile process now had a much better chance of success and might even provide "the possibility of earliest achievement of the desired result." Accordingly, the committee recommended construction of a diffusion plant, of a pile pilot plant and several full-scale production piles, and of facilities for producing heavy water. It urged continued developmental work on the electromagnetic process, including building a pilot plant to produce small quantities of U-235 for use in experiments. Finally, the committee recommended that companies with appropriate experience be given the responsibility necessary for operating all these projects. There no longer seemed any doubt concerning the feasibility of producing sufficient quantities of fissionable material.[20]

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[19] Quotations from WD Press Release, "Background Material for Use in Connection With Observance of the Fourth Anniversary, December Second, of the Scientific Event of Outstanding Significance in the United States Program of Development of Atomic Energy," 1 Dec 46, pp. 10-11, CMH. See also Compton, *Atomic Quest*, pp. 136-43; Smyth *Report*, pp. 70 and 177-81; Enrico Fermi, "The First Pile," *Bulletin of the Atomic Scientists* 18 (Dec 62): 19-24. Many of the other published works cited in this volume also contain lengthy descriptions of this event.

When the Military Policy Committee met on 10 December in General Groves's office, it had before it the report of the Lewis reviewing committee. The effect of this report and the events that had taken place in Chicago a week earlier were evident. At its meeting on 12 November, the Military Policy Committee had agreed to proceed with the construction and operation of a small electromagnetic separation plant; a pilot diffusion plant and, if practicable, a small production plant; and a plutonium plant.[21] Now a month later, the committee's decisions were far more optimistic. The pile method for producing plutonium, it decided, would "be carried forward full blast." Design for the pilot diffusion plant was well advanced and construction of test units was already under way at Columbia University. But rather than await completion of the pilot plant, the committee decided that work on the design and construction of a full-scale production plant should begin at once. The electromagnetic plant would be comprised of only 500 tanks "in order to get the earliest possible production of material, even though it may be in small quantities."[22] Thus, the Military Policy Committee had opened the way to rapid development of those processes that seemed most likely to provide large-scale production of fissionable materials.

Contract Negotiations

In rapid sequence during the next few weeks, Groves and the Manhattan staff oversaw negotiation of construction and operation contracts. The first of these was a letter contract for Du Pont on 21 December (effective as of 1 December 1942), pending completion of negotiations for a formal contract. It provided that the company secure designs, procure equipment, and erect facilities for a large-scale plutonium production plant, which it would also operate. Although the agreement of 1 December superseded the letter contract of 3 October, which had provided that Du Pont design and procure equipment for plutonium pilot installations, it did not specify that the firm would build a pilot plant. New location problems had made temporary postponement of settling this aspect expedient.[23]

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[20] Conclusions of Reviewing Committee, 4 Dec 42, Admin Files, Gen Corresp, 334 (Special Reviewing Committee), MDR. These conclusions, but without the statistical analysis portion, are also in the MPC Rpt, 15 Dec 42, MDR. See also Compton, *Atomic Quest*, p. 145.

[21] MPC Min, 12 Nov 42, MDR; Groves Diary, 10 Dec 42, LRG.

[22] MPC Min, 10 Dec 42, MDR; MPC Rpt, 15 Dec 42, MDR.

[23] Ltr Contract W-7412-eng-1, 1 Dec 42 (accepted 21 Dec 42), Tab B; Ltr, E. B. Yancey (Gen Mgr, Explosives Dept, Du Pont) to Lt Col J. M. Harman, 21 Dec 42, Incl to Memo, Maj A. Tammaro to Maj

Continued

Du Pont did not want to manufacture plutonium after the war and made clear it was agreeing to do so now only because of the expressed desire of the Army. Accordingly, in the cost-plus-fixed-fee contract, Du Pont waived all profits and accepted the assignment on the basis of reimbursement for the company's expenses on the project, plus a fixed fee of $1.00. However, arrangements were made to protect the firm from financial losses that might arise, because the hazards concomitant to the new process were not yet fully known or understood and conceivably could result in catastrophic losses for the company. Du Pont requested that the contract be submitted to the comptroller general of the United States for approval, particularly the sections covering reimbursement and indemnification, which the company feared might otherwise be upset by a future ruling. General Groves agreed and, as further assurance to Du Pont, Vannevar Bush also forwarded a letter to President Roosevelt, explaining the basis upon which the government was assuming responsibility for the unique hazards involved in the project.[24]

The Army had to negotiate with a number of companies for design, construction, and operation of the gaseous diffusion plant. Because the M. W. Kellogg Company had been working for nearly a year on research and design for a pilot plant, the Military Policy Committee decided at its 10 December meeting that this firm should also design and engineer the production plant. Hence, on the twelfth, General Groves requested Kellogg to act as architect-engineer for the diffusion project and, two days later, the company signed the necessary letter contract. To simplify operations and for reasons of security, Kellogg created a wholly-owned subsidiary, the Kellex Corporation,[25] for the project. After consulting with Kellex representatives, the Manhattan commander asked Union Carbide and Carbon Corporation to operate the plant. By late January, the Carbide and Carbon Chemicals Corporation—a subsidiary of Union Carbide—had signed a Manhattan letter contract and its engineers had begun working closely with Kellex on difficult design problems.

While earlier plans had called for Stone and Webster to build the diffusion plant, it soon became clear this job would overburden the engineering firm's already heavily taxed resources. Some consideration also was given to having Kellex construct the plant, but Groves decided that organization would have its hands full with the design and engineering problems. Groves remembered that he had been favorably impressed by the management, skill, and integrity of the J. A. Jones Construction Company of Charlotte, North Carolina, which had

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Claude C. Pierce, Jr. (Washington Liaison Office), sub: Du Pont Contract W-7412-eng-1, 5 Dec 44, Tab G. Both in OCG Files, Gen Corresp, Groves Files, Fldr 19, MDR. Copies of formal contract, completed on 8 Nov 43, on file in OROO. See also amendments and amplifications to this contract, same file, and Du Pont, *Stockholders Bulletin* 13 Aug 45, Admin Files, Gen Corresp, 161 (Du Pont), MDR.

[24] Groves, *Now It Can Be Told*, pp. 46–59; Memo, sub: Prelim Negotiations . . . , Incl to Ltr, DeRight to Groves, 30 Oct 43, MDR; DSM Chronology, 10 Nov 42, Sec. 23(b), OROO; Compton, *Atomic Quest*, pp. 131–34.

[25] The name Kellex was derived from "Kell" for Kellogg and "X" for secret.

built several large camps for the Army. The company accepted a letter contract covering this assignment on 18 May 1943.[26]

Arrangements already had been made for Stone and Webster to build the electromagnetic plant; however, because project leaders had decided that the task of operating the plant would be beyond the firm's practical capabilities, Groves offered the job to the Tennessee Eastman Corporation, a subsidiary of the Eastman Kodak Company, which had considerable experience in chemical processes. On 5 January 1943, Tennessee Eastman informed Groves that it would accept the job and the next day signed a letter of intent, pending negotiation of a formal contract. Within a few days key personnel of the company went to the Radiation Laboratory at Berkeley to familiarize themselves with Lawrence's experimental electromagnetic separation units.[27]

Upon examining the plans for various types of piles at the Metallurgical Laboratory in early November 1942, Du Pont engineers had rated the pile with a heavy water moderator second only to the helium-cooled graphite pile. It now appeared to be the logical choice "as a second line of defense" in case the graphite pile should fail. Accordingly, Du Pont recommended that the Manhattan commander take immediate steps to increase the monthly production of heavy water to approximately 3 tons per month: 0.5 tons to be produced by the electrolytic process at the Trail plant already under construction, and 2.5 tons by the distillation process at new plants to be built by Du Pont as adjuncts to ammonia-producing facilities already under construction by the company at government-owned ordnance plants. (At the request of the S-1 Committee, Du Pont earlier had investigated and ascertained the practicability of employing the distillation process to produce heavy water.)[28]

Both the Military Policy and S-1 Committees endorsed Du Pont's recommendations. Under the terms of a letter contract of 16 November, Du Pont agreed "to select a process and provide facilities for the production of heavy water in order to make available a supply of this material at the earliest possible date."[29] Groves authorized the company to expand facilities under construction at Morgantown Ordnance Works, near Morgantown, West Virginia; the Wabash River Ordnance Works, adjacent to Newport, Indiana; and the Alabama Ordnance Works, near Sylacauga, Alabama. (*See Map 2.*) Du Pont would build and operate the facilities, making as extensive use as possible of existing steam plants and other installations. Because Du Pont already had contracts with the Army's Ordnance Department for construction and operation of munitions-making facilities at each of these ordnance plants, it was agreed the additional work could be covered by supplements to these contracts, thus eliminating the need for the Manhattan chief to negotiate new agreements. Nevertheless, for reasons of security, each heavy water plant was to be built and operated almost entirely under the immediate supervision of the local area engineer and general supervision of the Manhattan District. The Ordnance Department, in Colonel Marshall's words, was "not to be involved in the design or knowledge of use of the product." [30]

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[26] MPC Min, 10 Dec 42 and 21 Jan 43, MDR; DSM Chronology, 12 Dec 42, Sec. 4, 28 Dec 42, Sec. 15(b), 30 Dec 42, Sec. 16, 14 Jan 43, Sec. 2(f), OROO; Groves, *Now It Can Be Told*, pp. 111-12; MDH, Bk. 2, Vol. 3, "Design," Sec. 3, Vol. 4, "Construction," Sec. 3, and Vol. 5, "Operation," pp. 2.1-2.4, DASA. Copies of formal CPFF contracts executed with M. W. Kellogg Co. on 11 Apr 44 (Contract W-7405-eng-23, effective 14 Dec 42), with Carbide and Carbon Chemicals Corp. on 23 Nov 43 (Contract W-7405-eng-26, effective 18 Jan 43), and with J. A. Jones Construction Co. on 2 Mar 44 (Contract W-7421-eng-11, effective 18 May 43) on file in OROO. See also List, sub: Signed Prime and Subcontracts Over $100,000, incl to Memo, Lt Col E. H. Marsden (Ex Off, MD) to Groves, 31 Aug 43, Admin Files, Gen Corresp, 161, MDR.

[27] Groves, *Now It Can Be Told*, pp. 96-97; DSM Chronology, 28 Dec 42, Sec. 2(e), OROO; MDH, Bk. 5, Vol. 6, "Operation," Sec. 2, DASA. Groves Diary, 30-31 Dec 42 and 5 Jan 43, LRG. Copy of formal CPFF contract executed with Tennessee Eastman Corp. on 7 Jun 43 (Contract W-7401-eng-23, effective 6 Jan 43) on file in OROO.

[28] DSM Chronology, 10 Nov 42, Sec. 23(i), and 14 Nov 42, Sec. 2(f)(k-m), OROO; MDH, Bk. 3, "The P-9 Project," p. 2.4, DASA.

[29] Copy of Ltr Contract W-7412-eng-4, 16 Nov 42, on file in OROO. See also MPC Min, 12 Nov 42, MDR.

Hanford Engineer Works

Until November 1942, project leaders had assumed that the main plutonium production plant would be located at the Tennessee site.[31] However, Du Pont was greatly concerned about the hazards of manufacturing plutonium on a large scale. An atomic explosion might devastate an area surrounding a plant and send a lethal cloud of radioactive dust and gases over a much larger zone. Such an explosion less than 20 miles from Knoxville could be a catastrophic disaster.

Groves himself already had qualms about placing a hazardous operation adjacent to electromagnetic and gaseous diffusion plants and near other important war production facilities in the Tennessee Valley Authority (TVA) region. Even if the physical effects were limited, an explosion would compromise the security of the whole project. If the plant were to be built at the Tennessee site, more land than originally contemplated would have to be acquired, a time-consuming process. Furthermore, there was a strong possibility that a power and labor shortage in the TVA area might interfere with construction and operation of the plutonium plant.

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[30] Dist Engr, Monthly Rpt on DSM Proj, 21 Jan 43, OCG Files, Gen Corresp, MP Files, Fldr 28, Tab A, MDR; DSM Chronology, 29 Dec 42, Sec. 4, OROO; Memo, Brig Gen R. E. Handy (Asst, OCO) to Maj G. W. Boush (Ord Ammo Prod Office), sub: New Constr at Alabama Ord Works . . . , 13 Jan 43, Admin Files, Gen Corresp, 161 (Du Pont), MDR; Memos, Handy to Alabama, Morgantown, and Wabash River Ord Works CO's, sub: New Constr at Alabama [and other] Ord Works, 1 Jan 43, Admin Files, Gen Corresp, 600.1 (Constr), MDR; MDH, Bk. 3, Secs. 2-3, DASA; Groves Ms, pp. 214-15, CMH.

[31] Section based on Groves, *Now It Can Be Told*, pp. 69-77; DSM Chronology, Nov 42-Jan 43, passim, OROO; MDH, Bk. 4, Vol. 3, "Design," Sec. 2, and Vol. 4, "Land Acquisition," Secs. 1-2, DASA; Diary of Col Franklin T. Matthias (hereafter cited as Matthias Diary), prior to 1 Feb 43, OROO; Rpt, Du Pont, sub: Special Investigation of Plant Site Location, 2 Jan 43, Incl to Ltr, E. G. Ackart (Engr Dept chief, Du Pont) to Groves, sub: Pro 9536, 5 Jan 43, Admin Files, Gen Corresp, 600.03, MDR; Rpt, OCE, sub: Basic Data on Hanford Engr Works, 19 May 43, same files, 601 (Hanford), MDR; Ltr, Robins (Act Chief of Engrs) to CG SOS, sub: Acquisition of Land for Cable Proj, Pasco, Wash., 8 Feb 43, Incl to Memo, O'Brien to Lt Col Whitney Ashbridge (CE Mil Constr Br), sub: Land Acquisition in Connection With MD, 17 Apr 43, same files, 601 (Santa Fe), MDR; Smyth *Report*, p. 81; MPC Rpt, 15 Dec 42, MDR; Compton, *Atomic Quest*, p. 166; Ltr, Groves to Herbert S. Marks (Power Div, WPB), 7 Feb 43, and related correspondence, Admin Files, Gen Corresp, 675, MDR.

All of these factors entered into the decision of the Military Policy Committee on 10 December that "a new plant site [for plutonium production] will have to be selected in an isolated area, but near power and water." [32] Groves sent Colonel Nichols and Lt. Col. Franklin T. Matthias to Wilmington on the fourteenth to discuss choice of a new site with Du Pont officials and with Compton and other representatives of the Chicago project. Matthias, an experienced civil engineer in civilian life, had been working with Groves on various problems, including the atomic energy program, and, while he had not yet been officially assigned to the Manhattan District, he was Groves's tentative choice for the key position of area engineer on the plutonium project. The Wilmington conference concentrated on developing guidelines, with the main emphasis on safety limitations, for the new site. When Matthias returned, Groves directed him to make an inquiry concerning sites where sufficient electricity would be available.

Matthias consulted first with those Corps of Engineers officials whom Groves had indicated would know a great deal about the wartime power situation. As a result, when he sat down with Groves and two Du Pont officials on 16 December to draw up more specific plans, he had considerable information about potential sites. The precise criteria that emerged from this discussion indicated that the site selected would have to be relatively large, isolated from centers of population, easily acquired, and with access to a large amount of water and power. Based on the estimated space needed for six atomic piles and three separation plants, an area 12 by 16 miles would be necessary for the production facilities alone. This amount of space would allow for contingencies well beyond the then anticipated requirements. It would permit a distance of 1 mile between each of the piles and 4 miles between each of the separation plants. Laboratories would have to be at least 8 miles away from these separation plants, and the workers' village and nearest railroad or highway at least 10 miles away. About 100,000 kilowatts of continuous power would be required, as well as 25,000 gallons of water (preferably soft) per minute for use in cooling the piles. A relatively mild climate, level terrain, a ready supply of sand and gravel, and ground and subsurface conditions favorable for heavy construction were also desirable for speed and economy in building the various facilities. And finally, along with other considerations, an area of comparatively low land values would reduce costs and facilitate acquisition.

As Groves, Matthias, and the two Du Pont representatives visualized it, the site would contain at least 700 square miles, with no main highway or railroad traversing it. This central area would consist of a restricted zone, 24 by 28 miles in size, in the center of which would be a 12- by 16-mile plant area. If possible, the site should be centered in a sparsely populated area, 44 by 48 miles in size, with no towns of more than one thousand inhabitants. The outer 10 miles of this last-named area would constitute a buffer zone from which all residents would be removed, although it would not necessarily have to be purchased by the government.

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[32] MPC Min, 10 Dec 42, MDR.

Groves favored the Pacific Northwest, convenient to the growing power resources of the great Bonneville Power Administration (BPA) on the Columbia River. (*See Map 2.*) In this he was supported by Brig. Gen. Thomas M. Robins, the assistant chief of the Corps of Engineers, and Carl H. Giroux, the Corps' chief power expert, who also suggested possible sites in the southwest as alternate choices.

Matthias and the Du Pont representatives investigated possible site locations from the California-Arizona border near Hoover Dam to the great Grand Coulee Dam in northeast central Washington. They checked a score of potential locations and studied maps and detailed reports prepared by the Los Angeles, Sacramento, and Seattle district engineers. Four sites appeared promising: two in Washington—one near Grand Coulee Dam and the other in the vicinity of Hanford, a community in the south central part of the state; a third on the Pit River, near the almost completed Shasta Dam in northern California; and the last on the California-Arizona border in the Needles-Blythe area, easily accessible to power from Hoover Dam. Because Matthias and his colleagues strongly favored the Hanford location, General Groves directed Col. John J. O'Brien, head of the Engineers' Real Estate Branch, to begin a preliminary appraisal of the site. Meanwhile, Groves also made a personal inspection of the area on 16 January 1943 and gave it his approval.

Before asking for War Department authorization for acquisition of the Hanford site, Groves sought and received the BPA's assurance that it could provide adequate power when needed. The site selection team had found that the BPA's only recently completed trunk transmission line running between Grand Coulee and Bonneville Dams traversed the western portion of the projected Hanford site, with a major substation located at Midway, just outside the site area. This meant that a connection into the BPA system could be made quickly, guaranteeing an initial power supply for plant operations as soon as needed.

The Hanford Engineer Works, as the plutonium production site was designated officially, comprised about 670 square miles (slightly smaller than contemplated) in an isolated part of the south central Washington region near the confluence of the Columbia and Yakima Rivers. It lay primarily in Benton County, but also included parts of Yakima, Grant, Adams, and Franklin Counties. Very sparsely settled, the site included only three tiny communities: Hanford, White Bluffs, and Richland. A few miles to the southeast was the larger town of Pasco, an important rail center. Yakima, some 20 miles to the west, was a small city serving as a trade center for a surrounding rich agricultural area.

The major population centers of Seattle, Tacoma, Portland, and Spokane were all more than 100 miles distant. The Columbia River provided ample cold water of unusually high purity for cooling; the terrain and climate were close to ideal. Bounded generally on the south by the Yakima River, on the east and north by the Columbia, and on the west and southwest by a steep 3,500-foot ridge line, the site was, for the most part, flat or slightly rolling, with only the 1,000-foot-high Gable Mountain rising to the north from the otherwise unbroken terrain. Excellent rail transportation lines ran nearby and a fairly extensive, existing road system could be extended without much difficulty over the level terrain.

The shape of the site was irregular, but roughly circular, extending on a north-south line about 37 miles at its widest point and with a maximum east-west breadth of about 26 miles. The tentative plan called for purchase of a little less than half of the land and for lease of the remainder. The outer 10-mile security buffer zone was no longer considered necessary, but two smaller areas totaling some 60 square miles, adjacent to an important sector of the site, were to be leased for security purposes. The estimated cost of acquiring the entire site was slightly over $5 million.

With Under Secretary of War Patterson's approval on 9 February, acquisition began immediately. By late spring much had been acquired, but gaining control of the entire site would be a long process. Had General Groves been able to foresee the troubles that lay ahead, he might well have selected another site.[33]

Plutonium Semiworks: Argonne vs. Tennessee

The decision to shift the site of the main plutonium production plant from Tennessee to the Pacific Northwest threw open to question once again the location of the semiworks for the pile process.[34] In December 1942, after learning that the main production facilities probably would not be built at the Tennessee site, Arthur Compton and his Metallurgical Laboratory staff favored going back to the original plan of centering plutonium experimentation, testing, and pilot plant production of fissionable material at the conveniently situated Argonne Forest site.[35] (*See Map 2.*) But Du Pont, having full responsibility for the plutonium program, strongly opposed this alternative. Du Pont engineers placed considerable emphasis on the hazards involved in setting up operations near a large metropolitan area; they did not think there would be enough room at the Argonne site; and they also saw certain disadvantages in having the semiworks readily accessible.

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[33] See Ch. XV for a detailed account of land acquisition at the Hanford site.

[34] A semiworks is a developmental plant in which the equipment and the amounts of materials used are larger than those employed in regular laboratory research. In the context of this discussion, the term *semiworks* refers to the intermediate stage for transforming research data into a large-scale production process. See MDH, Bk. 4, Vol. 1, "General Features," App. A3, and Vol. 2, "Research," Pt. 2, pp. 2.1–2.3, DASA.

[35] Subsection based on Compton, *Atomic Quest*, pp. 150–52 and 170–72; Groves, *Now It Can Be Told*, pp. 68–69; DSM Chronology, 13–14 Sep 42, each Sec. 2(a), OROO; ibid., 6, 8–9 Jan 43, each Sec. 3, OROO; ibid., 16 Jan 43, Sec. 5, OROO; Min, Tech Council, 10 and 28 Dec 42 (Rpt CS–371), ANL; Hewlett and Anderson, *New World*, pp. 190–91; Supp. No. 1, 4 Jan 43, to Ltr Contract W–7412–eng–1, 1 Dec 42, OCG Files, Gen Corresp, Groves Files, Fldr 19, Tab B, MDR; Completion Rpt, Du Pont, sub: Clinton Engr Works, TNX Area, Contract W–7412–eng–23, 1 Apr 44, p. 2, OROO; Ltr, Williams to Yancey, 12 Jan 43, Admin Files, Gen Corresp, 337 (Univ of Chicago), MDR; Groves Diary, 9–11 and 16 Jan 43, LRG; MDH, Bk. 4, Vol. 2, Pt. 2, pp. 3.1–3.2, DASA.

Du Pont also objected to the Metallurgical Laboratory staff assuming it could dictate plans and policies on matters that the company held to be its own prerogatives. Compton had already detailed physicist Martin D. Whitaker, who had worked with Fermi on the first pile, and other staff members to supervise development of research facilities that would operate in connection with the semiworks. Du Pont, however, had a long-established policy that a research staff must not be permitted to exert too much control over the design and construction phases of a project. When this happened, the company had found, the staff had a tendency to keep making changes that seriously interfered with construction progress. In the world of industry, Du Pont felt, the research laboratory was the servant of management, not its master.

General Groves realized that if the differences between the Metallurgical Laboratory scientists and the Du Pont industrial engineers could not soon be resolved, there was serious question as to whether they would ever function efficiently as a team. From the Army's point of view, achievement of a harmonious working agreement on the design, construction, and location of the semiworks was crucial, not only for present operations but also for future plans regarding the main production plant. Now that Du Pont had made significant progress on its design and procurement of essential equipment for the works, both Groves and Du Pont officials felt that no further delays could be tolerated. Furthermore, the efforts of Crawford Greenewalt, Du Pont's liaison representative, to establish an agreement with the Chicago scientists had not been too successful. Consequently, on 4 January 1943, Du Pont accepted the Army's alternative solution that the company design and construct the buildings to house the pilot pile and chemical separation facilities.

The Army–Du Pont agreement, however, still left the question of the location of the semiworks unsettled, and this issue was the main item on the agenda of a conference held in Wilmington on 6 January. Hoping to get a prompt decision, General Groves sent two of his ablest officers from District headquarters—Colonel Nichols and Lt. Col. E. H. Marsden—to assist the area engineer at Wilmington, Maj. William L. Sapper, in presenting the Army's views to the representatives of Du Pont and the Metallurgical Laboratory. The Manhattan chief's strategy succeeded; the meeting closed with a tentative agreement that the semiworks be erected at the Tennessee site.

The tentative agreement almost, but not quite, settled the issue. Under a previous agreement governing relations between Du Pont and the Metallurgical Laboratory, all important decisions had to receive final approval from both Compton and Greenewalt. Greenewalt's assent was a foregone conclusion, but Groves knew that Compton was not likely to give in without at least an effort to salvage something for the Argonne site. In anticipation of this, he sent Colonel Nichols to Chicago.

COL. E. H. MARSDEN *(1946 photograph). Marsden became executive officer of the Manhattan District in July 1943.*

Conferring with Compton and his assistant, Norman Hilberry, Colonel Nichols stressed the greater safety of the Tennessee site. Nichols's argument, however, failed to alter Compton's conviction that the Argonne site was adequately safe and eminently suitable. Furthermore, he contended, to shift to Tennessee now would be a severe blow to the morale of his laboratory staff. The Metallurgical Laboratory did not have enough scientists and technicians to staff another major research center in addition to those at Chicago and Argonne. If the decision was going to be to erect the semiworks in Tennessee, Compton concluded, then the Argonne Laboratory should be authorized to build for its own use a pile of sufficient size to produce the supply of plutonium it needed for experimental purposes.

Nichols suggested to Groves that a meeting between Compton and Roger Williams, head of Du Pont's TNX Division (the company's special organization for carrying out its atomic energy program commitments), might pave the way to an agreement. Sensing that the time had arrived for decisive action on his part, Groves immediately arranged to meet with Williams, Compton, Hilberry, and Fermi on 11 January in Chicago. Colonel Marshall also came from District headquarters in New York to assist in pressing for a decision.

The meeting opened with Williams reiterating Du Pont's opposition to Argonne. Then the group considered alternative sites. Williams warned that a site other than Tennessee or Argonne would result in a further serious delay. Location at Hanford, for example, would require too much time, would very likely interfere with construction of the production facilities, and would place the installation too far away from Wilmington and Chicago. Finally, with Compton still reluctant, the group agreed that the semiworks should be built in Tennessee.

The question of who would operate the semiworks also came up for discussion at the Chicago meeting. Taking advantage of Williams's presence, both Groves and Compton proposed that Du Pont operate as well as build the semiworks. But Williams, pleading lack of authority, avoided making a commitment.

The next opportunity for discussing the semiworks problem came at a conference on pile project policies, held in Wilmington on 16 January. General Groves was away on an inspection trip at the Hanford site, but Colonel Nichols and Maj. Arthur V. Peterson, the Chicago area engineer, were on hand. Compton, accompanied by Hilberry and Whitaker, came determined to persuade Du Pont that, as builder and operator of the main production plant, it logically should also perform both these functions for the semiworks. But Williams, acting again as spokesman for a strong Du Pont delegation, had ready some effective counterarguments. In perfecting any new technical process, he pointed out, Du Pont always left operation of the experimental plant stage to the research staff. Furthermore, Williams continued, Du Pont felt especially unqualified to operate the semiworks because it involved major processes entirely outside the field of chemistry, the company's normal area of specialization. Williams thus proposed that the University of Chicago operate the semiworks and Du Pont furnish the university with engineers, accountants, and similar personnel.

Compton obviously was profoundly shocked by Williams's proposal. Neither in terms of its fundamental purpose nor of its proper function, he said, could a university operate an essentially industrial enterprise at a location some 500 miles from its campus. The Du Pont representatives countered with the observation that the university would be performing at least one appropriate function: educating company personnel in the special art of making plutonium. Compton knew that the Army would prefer not having Du Pont take on operation of the semiworks because it believed the firm's resources would be taxed to the limit in building and operating the plutonium production plant and in carrying out its other war contracts. He agreed to consult with Conant in Washington, D.C., and with the administration of the University of Chicago.

There can be little doubt that Compton still held serious reservations on the task of operating the semiworks. He was even more dubious that the University of Chicago administration could be persuaded to agree to the task. Conant gave him no encouragement; the Harvard president took a dim view of a university running an industrial plant. Hence, perhaps no one was more relieved than Compton when the University of

Chicago agreed to accept a contract for operation of the plutonium semiworks. An exchange of letters between Groves and University of Chicago President Robert Maynard Hutchins in March 1943 provided the necessary formal agreement for negotiation of a War Department contract. Hutchins, who happened to be absent from the campus at the time the actual decision was made, remarked to Compton the next time he saw him on the street: "I see, Arthur, that while I was gone you doubled the size of my university." [36]

For General Groves, successful resolution of the plutonium semiworks problem was a major administrative achievement. As the program developed, this accomplishment set the standard for future cooperation between Du Pont and Compton's plutonium research and development activities—a key factor in working out the far more complex problems of building and operating the great plutonium production works at Hanford.

Program Funding

As the size and complexity of the atomic energy program increased, the Army had to face the problem of additional funding. The decision to develop four processes was obviously going to cost a great deal more than could be covered by the original financial commitment. A few days after Groves took command of the Manhattan Project in September 1942, Colonel Marshall discussed with him the necessity for speed in appropriating the remainder of the $85 million earlier approved for the program. Only $38 million had actually been allocated during the summer, and the rest would soon be needed. Groves, however, did not take any immediate action. In early November, Marshall again raised this question but now reported that future needs would total around $400 million. Agreeing with this estimate, Groves earmarked the remainder of the $85 million for the Manhattan Project and laid the groundwork for a drastic increase in its funding.

On 15 December, the Military Policy Committee forwarded the $400 million estimate to the President, recommending that the necessary additional funds be made available early in 1943. Also, the committee urged that General Reybold, the Engineers chief, be authorized to enter into contractual obligations beyond the funds then under his control, should obstacles arise to prevent an early appropriation of additional money.

Roosevelt approved the committee's recommendations, and preparations were begun to secure the funds confidentially within regular Army appropriations. By April 1943, the need for General Reybold to exercise his authority to spend additional money was clear. Some $50 million would be required by the end of June and an additional $286 million within another six months. In late May, General Somervell, the Army Service Forces commander,[37] authorized Reybold to make available to the Manhattan Project $300 million from engineer funds; however, by this time, an additional $400 million was needed to carry the project through to the end of 1944. This sum, too, was soon made available under disguised purposes in the Military Appropriations Act of 1944. At least for the immediate future, it appeared fiscal requirements had been met. When the problem rose again in the following year, new means would have to be devised to solve it.[38]

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[36] Quoted in Compton, *Atomic Quest*, pp. 172–74. See also Dist Engr, Monthly Rpt on DSM Proj, 21 Jan 43, MDR. In his report the district engineer already refers to the University of Chicago as the "operator" of the plutonium semiworks, more than six weeks before the university had formally agreed to take this responsibility. Other items pertinent to negotiation of the semiworks operation contract are Ltr, Conant to Compton, 4 Mar 43, OSRD; Ltrs, Groves to Hutchins, 10 Mar 43, and Hutchins to Groves, 16 Mar 43, Admin Files, Gen Corresp, 161, MDR; MDH, Bk. 4, Vol. 2, Pt. 1, p. 2.3, and Pt. 2, pp. 3.1–3.2, DASA; WD–Univ of Chicago Contract W–7405–eng–39, 1 May 43, OROO, with pertinent extracts found in Cert of Audit MDE 179–46, E. I. du Pont de Nemours and Co., 30 Jun 46, Fiscal and Audit Files, Cert of Audit (Sup), MDR.

By spring of 1943, approximately six months after General Groves's assignment to the Manhattan Project, major advances in the atomic program provided more promise than at any time in the past of success in building an atomic bomb. These included achievement of a self-sustaining chain reaction in the pile method; assurance of an adequate supply of uranium ore; selection of plant sites and work on their acquisition; letting of contracts for construction and plant operation; and appropriation of requisite funding through 1944. Work on the design of a bomb was progressing, bolstered by satisfactory progress in the research and development of methods to isolate a sufficient quantity of U-235 and of the apparent feasibility of obtaining and using plutonium as a fissionable explosive. Project officials now believed there was a good chance that the production of bombs on a one-per-month basis would begin in the first half of 1945. By mid-1943, the Manhattan District had taken over administration of most of the OSRD research contracts and was preparing to assume responsibility for the rest in short order.[39] Now that the period of joint Army-OSRD administration of the program was coming to an end, all work on the development of the atomic bomb would continue under the direction of the Army.

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[37] Initially called the Services of Supply (SOS), the name was changed to Army Service Forces (ASF) by WD GO 14, 12 Mar 43.

[38] Correspondence (Sep 42–May 43) on this subject filed in Admin Files, Gen Corresp, 110 (Appropriations), MDR. See also MPC Rpt, 15 Dec 42, MDR; ibid, 12 Aug 43, Incl to Memo, Groves (for MPC) to Chief of Staff, same date, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab E, MDR; MPC Min, 5 May 43, MDR; MDH, Bk. 1, Vol. 5, "Fiscal Procedures," App. B2, DASA.

[39] Dist Engr, Monthly Rpt on DSM Proj, 23 Apr–24 May 43, MDR.

CHAPTER VI

The Electromagnetic Process

Considered from the viewpoint of basic military objectives, the single most important problem of the Manhattan Project was how to produce fissionable materials in the quantity and of the quality required to make an atomic bomb. By the end of 1942, because project leaders were reasonably certain that a considerably greater amount of fissionable materials than had been previously estimated would be needed, the Military Policy Committee decided to proceed with full-scale development of three production methods: for plutonium, the pile process; for U-235, the gaseous diffusion and electromagnetic processes. Of the three, project leaders agreed that the electromagnetic method most likely would be the first to produce an appreciable quantity of fissionable material, although not nearly enough for an atomic weapon.

There remained, however, some major reservations concerning the feasibility of the electromagnetic method as a large-scale production process. In its recommendation that the Army initiate construction of a 100-grams-per-day electromagnetic plant, the S-1 Executive Committee indicated that all contractual arrangements should be drawn up so that they could be readily canceled should "subsequent developments warrant . . . a change of plans." [1] Similarly, following its fact-finding tour of the project's research laboratories, the Lewis reviewing committee reported: "We do not see that the electromagnetic method presents a practical solution to the military problem at its present capacity. . . ." [2] An electromagnetic plant capable of producing 1 kilogram of fissionable material per day would require at least twenty-two thousand separation tanks, whereas the same output could be achieved by a diffusion plant of only forty-six hundred stages or three 250,000-kilowatt plutonium piles. These figures implied that an electromagnetic plant would take longer to build, use up far more scarce materials and manpower, require more electrical power to operate, and cost a much greater sum than either a gaseous diffusion or plutonium plant with equivalent production capabilities.[3]

In spite of the drawbacks of the electromagnetic method as a large-scale industrial process, each of the three committees concluded that the method presented advantages which outweighed its obvious defects. Based on a proven laboratory tool, the mass spectrograph, the electromagnetic method was the most certain of the processes to produce at least some fissionable material, albeit not very efficiently. Also, a mass production level could be more rapidly attained because an electromagnetic plant could be built in relatively small, self-sufficient sections, each of which could begin producing material as soon as it was completed. Neither the gaseous diffusion nor pile methods had this advantage. Finally, too, General Groves and S-1 Chairman James B. Conant, as well as several of the other project leaders, perceived the leadership of Ernest Lawrence as giving a distinct advantage to the electromagnetic process. The University of California scientist repeatedly had demonstrated an ability to find quick, practical solutions to even the most difficult technical problems that had arisen in development of the process.[4]

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[1] DSM Chronology, 13 Sep 42, Sec. 2(e), OROO.

[2] Rpt of Lewis Reviewing Committee, in MPC Rpt, 15 Dec 42, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab B, MDR.

[3] Conclusions of Reviewing Committee, 4 Dec 42, Admin Files, Gen Corresp, 334 (Special Reviewing Committee), MDR.

Electromagnetic Research and the Army, 1942–1943

Only weeks after Colonel Marshall's assignment as district engineer, the Army began to take over administration of engineering, construction, procurement, and related aspects of the electromagnetic program, leaving to the Office of Scientific Research and Development (OSRD) continued supervision of research and development activities and fiscal and budgetary matters. In August, Marshall opened the California Area Engineers Office at Berkeley and assigned Maj. Thomas T. Crenshaw as area engineer and Capt. Harold. A. Fidler as his assistant. Crenshaw soon established himself in the university's Donner Laboratory, adjacent to Lawrence's office.[5]

During the fall and winter of 1942–43, Major Crenshaw's office became increasingly involved in procurement of materials and equipment for the research and development program and with providing liaison between the Berkeley program and other elements of the atomic project. In this period, an important phase of the staff's liaison function was arranging visits to the Radiation Laboratory for the various individuals and groups involved in trying to decide what the role of the electromagnetic process should be.[6]

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[4] MDH, Bk. 5, Vol. 2, "Research," pp. 1.6–1.8, DASA; Groves, *Now It Can Be Told*, p. 96; Smyth *Report*, pp. 145–46; Stone and Webster, *A Report to the People*, p. 18.

[5] MDH, Bk. 5, Vol. 2, pp. 2.1–2.2, DASA; Memo, Crenshaw to Dist Engr, sub: Weekly Progress Rpt, 22 Aug 42, Admin Files, Gen Corresp, 001 (Mtgs), MDR; Interv, Author with Fidler, 6 Jul 64, CMH.

[6] Subsection based on DSM Chronology, 13–14 Sep 42, Sec. 2(e), 11 Nov 42, Sec. 2(d), 14 Nov 42, Sec. 2, OROO; Hewlett and Anderson, *New World*, pp. 96, 112, 141–47, 157–58; Rpt, Capt Arthur V. Peterson, sub: Visit to Berkeley Proj, 17 Oct 42, Admin Files, Gen Corresp, 680.2 (Berkeley), MDR; Groves Diary, 1–9 Nov 42, LRG; Rpt, sub: R & D at Univ of Calif Rad Lab, 24 Apr 45 (prepared as Bk. 5, Vol. 2, of MDH), Figs. 6 and 7, SFOO; MDH, Bk. 5, Vol. 2, pp. 1.4, 3.9–3.10, 4.1–4.3, and Vol. 3, "Design," pp. 2.6–2.10, 3.5–3.6, App. C6, DASA; MPC Min, 10 Dec 42, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; Memo, Lawrence to Fidler, 8 Mar 43, LRL. For a detailed discussion of the electromagnetic process, see the appropriate volumes in Division 1, *Electromagnetic Separation Project*, of the National Nuclear Energy Series (see Bibliographical Note).

These visitors came to learn firsthand more about Lawrence's method and how it was progressing. After clearances by Crenshaw's staff and the laboratory's security officials, Lawrence and his technical staff showed them the impressive physical facilities and equipment. They toured the conventional laboratories on the university grounds and then the great domed cyclotron building with its adjacent shops and facilities located in the hilly area east of the main campus. There they observed the intensive investigations under way into the physics and chemistry of separating U-235 from ordinary uranium by the electromagnetic method. Lawrence had committed the largest part of his staff and resources to the physics or physical aspects of the separation process, centering this research in two buildings, one housing a 37-inch magnet and the other a 184-inch magnet. The availability of these cyclotron magnets, which were exceptional in size and strength, was the single most important factor in making possible research into the feasibility of the electromagnetic method as a production process. Research into the chemical aspects of the separation process under Lawrence's direction was a much smaller program, with laboratory investigations in progress at both the Berkeley and Davis campuses of the University of California.[7]

Lawrence and his scientist colleagues repeatedly emphasized to visitors that their ultimate success or failure depended on development of the calutron—a name derived from the words *California, university,* and *cyclotron.* If they could redesign the calutron, a novel hybridization of two well-known laboratory tools—the mass spectrograph and the cyclotron magnet—so that it would operate not only intermittently, as in the laboratory, but also on an around-the-clock, day-after-day, month-after-month basis without breakdown, then they would have the means for producing a significant amount of enriched uranium for an atomic weapon.

Lawrence had made some design modifications in the first calutron, installed in the 37-inch magnet, following successful experiments in February 1942. He found, however, that he was unable to test the validity of these changes until he had access to a more powerful magnetic field. This became available in the spring with completion of the 184-inch magnet. The redesigned calutron became the prototype for the first production units at the Tennessee plant. Mounted on a metal door, this calutron could be taken out of its vacuum tank as a single unit, which greatly facilitated recovery of any of the valuable uranium feed material adhering to components and also expedited reloading and maintenance.

At the same time, Lawrence's group had also developed the essential supporting components—magnet, vacuum pumps, cooling systems, and electrical power and control equipment. While these components were more conventional in design and function, they still had to be adapted to conform to the requirements of the electromagnetic process. The design engineers, for example, decided that the most efficient layout for the magnets and tanks was in an oval-shaped pattern, thus creating the racetrack configuration that characterized each major element of the production plant. A special system of pumps achieved and maintained the required vacuum equivalent of one one-hundred-millionth of normal atmospheric pressure in hundreds of calutron tanks.

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[7] Not all research into the chemistry of the electromagnetic process was located at the University of California, Berkeley. The OSRD also had contracted with Brown, Purdue, and Johns Hopkins to investigate some aspects. Subsequently, too, the electromagnetic production plant operator, the Tennessee Eastman Corporation, carried on chemical research for the process in Eastman Kodak laboratories in Rochester, N.Y., and near the plant site in Oak Ridge, Tenn. See MDH, Bk. 5, Vol. 2, pp. 1.1–1.2, 3.1, 4.1, DASA.

Involving less space, fewer personnel, and mainly conventional procedures, the chemical aspects of the electromagnetic process must have appeared far less important; nevertheless, both the first and final stages of the process were essentially chemical operations and required new techniques and chemical substances about which relatively little was known. For the first stage the chemists had to develop a method of large-scale production of uranium tetrachloride, the most promising feed material for the calutrons. For the last stage they had to devise an efficient method to extract the enriched uranium produced by the calutrons and prepare it for use by the Los Alamos Laboratory scientists in developing an atomic bomb. By early 1943, the chemists had made substantial progress on both the feed material and extraction techniques.

Virtually all who visited the Radiation Laboratory at Berkeley came away impressed with the feasibility of the electromagnetic research program and with the eminently empirical approach of Lawrence and his staff. This approach, characterized by a frequently demonstrated talent for finding practical solutions to every problem, inspired project leaders with further confidence in Lawrence's process as they prepared to transform the research data and devices into an industrial production plant at the Tennessee site.

Research and Development, 1943–1945: Radiation Laboratory

As the electromagnetic program shifted from basic research to the problems of designing, building, and operating a major production plant, the Army brought the project more directly under its administrative jurisdiction. Replacing OSRD contracts with War Department contracts was an important step in attaining this goal.

The University of California accepted a letter contract from the district engineer, effective 1 April 1943, pending the working out of details of a formal War Department contract. Then on the sixteenth, representatives of the Manhattan District, OSRD, and the university's Board of Regents reached final agreement on terms of a new prime contract covering most aspects of the atomic research program in progress at the Radiation Laboratory. The new contract went into effect on 1 May, bringing to an end the OSRD's formal connection with the California project. Henceforth, until the Army terminated control of the atomic energy program at the end of 1946, this new agreement, renewed annually, provided the contractual basis for continuing the research and development activities requisite to construction and operation of the electromagnetic plant in Tennessee. In recognition of the overriding requirements of security, the regents assented to leaving all details of managing the program as they related to the university to their secretary, Robert M. Underhill, and to Lawrence. Some subsequent modifications in the prime contract relating to health and chemistry activities did not result in major changes in the Radiation Laboratory program, nor in the Army's relationship to it.[8]

In general, fiscal arrangements remained the same as they had been under the OSRD contract, with one significant exception. The War Department contract provided that an amount equal to 25 percent of the total funds allotted for salaries and wages could be used by the university to defray its overhead expenses in operating the Radiation Laboratory; the OSRD contract had provided 30 percent for this purpose. Partly in reaction to this reduction in overhead allotment, in November 1943 business representatives of the University of California, University of Chicago, and Columbia University requested the Manhattan District to include a provision in prime contracts guaranteeing the universities, in view of their nonprofit status, against a profit or loss in administering atomic research programs. Following several months of negotiation with the universities, the District agreed in May 1944 that the government would compensate them if their overhead costs should exceed their 25 percent allowance and, conversely, they would return to the government any surplus that might result from this allowance.

At the same time, the District added a provision in the prime contracts with California, Chicago, and Columbia for a so-called welfare fund. Thus, in the case of California, the government established a fund of $500,000, which was to continue in existence for a period of ten years after termination of its contract with the War Department. Any claims made by Radiation Laboratory employees or their relatives during that time because of death or disability resulting from a specified list of unusual hazards in atomic research activities—for example, radioactivity, high voltages, and movement of objects by magnetic forces—would be paid from this fund. The government provided the money for the fund and the university administered it with assistance of a private insurance company. The welfare fund took the place of the

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[8] Ltr Contract W-7405-eng-48, Marshall to Univ of Calif, Attn: R. M. Underhill, 1 Apr 43, copy in MDH, Bk. 5, Vol. 2, App. C3, also see pp. 2.1-2.3, DASA; Historical Summary of Contract W-7405-eng-48, May 43-Aug 47, comp. by Russell H. Ball, Jan 48, with significant correspondence on subconstracts W-7405-eng 48A (health) and W-7405-eng 48B (chemistry) under Tab 6, pp. 35-49 and 50-60, SF00; NDRC and OSRD Contracts with Univ of Calif, Jun 41-Sep 42, SFOO; Rpt, sub: R & D at Univ of Calif Rad Lab, 24 Apr 45, pp. 19-28, SF00; Fidler Interv, 6 Jul 64, CMH. The Radiation Laboratory health reseach program, directed by J. D. Hamilton, functioned as a part of the project-wide health program of the Mannattan District, which was centered at the Metallurgical Laboratory in Chicago. A chemistry program, directed by W. M. Latimer, had grown out of the participation of the University of California's chemistry department in the early phases of atomic research at Berkeley. When the OSRD contracts for these programs came up for renewal in June 1943, the Army continued them as separate projects operating under the prime contract.

OSRD's private indemnification insurance, which the District had continued only until such time as a government-financed system could be established.[9]

The Army's first major administrative task after the formal contract became effective was to supervise preparation of the program's fiscal year (FY) 1944 budget. As of mid-1943, cost of the program had reached about $500,000 a month, and was following an upward trend. District and university officials agreed upon a request for $7.5 million (an average of $625,000 per month) for FY 1944. By November, however, Regents Secretary Underhill was warning Captain Fidler, who had replaced Major Crenshaw as area engineer, that even this increased sum was not likely to be enough to meet mushrooming costs. Underhill estimated that the university would need an additional $1.5 to $2 million in the remaining months of FY 1944. Consequently, the District approved a supplementary appropriation, bringing total cost to $9.5 million.

The Army's negotiations with the University of California for the FY 1944 budget set the pattern for subsequent years. Even after the electromagnetic production plant began operations in the spring of 1944, the electromagnetic research program continued to require a large staff to solve production problems and make improvements in plant operations. Thus, for the FY 1945 budget, the Army scheduled $8.5 million, although only $6.5 million was actually expended. By the time the war ended in August 1945, total outlay for the electromagnetic research program had reached about $20 million—some $3.7 million under OSRD contracts before 1 May 1943 and the remainder under the War Department contract.[10]

Increases in cost reflected the very rapid expansion of the Radiation Laboratory, both in terms of personnel and physical facilities. In May 1943, when the Army assumed full responsibility for the research program, the laboratory was occupying a number of buildings in two different locations on the Berkeley campus. Starting out modestly in 1941 in the prewar Radiation Laboratory building, atomic research activities gradually had spread into four adjacent structures, including the new Donner Laboratory, and, by mid-1942, to the new 184-inch-cyclotron building in Berkeley Hills. Soon the circular-shaped cyclotron building, standing on the slope of a hill some 900 feet above the campus proper, was ringed with smaller additional structures housing a machine shop, chemistry laboratories, warehouses, and other facilities essential to operating and testing calutrons and other equipment prototypes designed for the production plant in

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[9] Rpt, sub: R & D at Univ of Calif Rad Lab, 24 Apr 45, pp. 24-27, SFOO; MDH, Bk. 5, Vol. 2, p. 2.3, DASA; Ltr, Underhill to Nichols, 13 Mar 44, Tab 6, Historical Summary of Contract W-7405-eng-48, SFOO; Ltr and Incl, Nichols to Lawrence, 15 Apr 44, Tab 9, ibid.

[10] Rpt, Underhill, sub: Hist of Contract W-7405-eng-48, [probably 1948], Tab 1; Ltr, Underhill to Fidler, 10 Nov 43, Tab 5b; Ltr, Fidler to Underhill, 16 Feb 44, Tab 5e; Memo, Fidler to Dist Engr, sub: Contract W-7405-eng-48, 18 Feb 44, Tab 5d; Memo, Priestly to O. Lundberg, sub: Budgets for 1944-45 for Projs 48, 48A and 48B, 29 Jun 44, Tab 7; Ltr, Nichols to Univ of Calif Regents, Attn: Underhill, 20 Mar 45, Tab 8a. All in Historical Summary of Contract W-7405-eng-48, SFOO. See also Ltr, Lawrence to Nichols, 24 Mar 44, Admin Files, Gen Corresp, 001 (Mtgs), MDR.

Tennessee. Part of the chemistry program, too, had overflowed facilities on the Berkeley campus and been moved to the University of California's School of Agriculture at Davis.

For each new structure or renovaton, Lawrence and his staff laid out preliminary plans and estimates, which went to the area engineer's office for approval and checking. Detailed supervision of construction was left to Radiation Laboratory business manager Kenneth Priestly. To expedite the work and minimize security problems, Priestly let contracts to the local firms that the university had employed extensively in the past. For the same reasons, most contracts were of the fixed-fee or lump-sum type. By mid-1945, Priestly had allocated for various types of construction more than $300,000 from funds allotted under the University of California's War Department contract.[11]

By far, the largest expenditures were for salaries and wages of the research staff and for the laboratory equipment and materials they needed. Annual payroll costs were running at a level of nearly $3 million in May 1943, when the Army assumed full control of the Manhattan Project, and had reached a high point of about $3.7 million a year later. Equipment and other expenses, although somewhat less than personnel, attained a maximum of nearly $300,000 a month in November 1943.[12]

Starting in 1941 with personnel of the University of California's Radiation Laboratory, which Lawrence had been building up since the 1930's, the staff at Berkeley grew rapidly. By May 1943, as primary emphasis began to shift from basic research to engineering and developmental problems and training of operational personnel for the Tennessee plant, it numbered almost nine hundred scientists, technicians, engineers, mechanics, clerks, skilled workers, and others. By mid-1944, there were nearly twelve hundred on the Radiation Laboratory payroll, and total employment remained well above one thousand until the end of the war.[13]

The basic organization of the Radiation Laboratory had taken shape under Lawrence's guidance in the years immediately preceding the outbreak of World War II and conformed, more or less, to the conventional pattern for peacetime academic research programs, with a major division into research and administrative staffs. While Lawrence, as director, theoretically exercised equal control over both divisions, he devoted his energies to the research staff, delegating to the OSRD and then the Army the administration of nonscientific activities. Major responsibilities for these activities devolved upon Captain Fidler, the area engineer. Fidler worked closely with Regents Secretary Underhill, and also with Priestly who, as the laboratory's business manager, supervised administration of finances and personnel.[14]

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[11] Constr Completion Rpt, Univ of Calif Rad Lab, sub: Contract W-7405-eng-48, 1 May 43-1 Aug 46, comp. by Calif Area Engrs Office, 1 Sep 46, SFOO (with maps of the two campus areas where major laboratory facilities were located and with selected photographs of important buildings); Rpt, W. B. Reynolds (Rad Lab Man Engr), sub: Notes on 184-inch Cyclotron, 16 Jun 45, SFOO; "Domed Building Fitted to Research Needs," *Engineering News-Record*, 9 Apr 42, pp. 64-66; MDH, Bk. 5, Vol. 2, pp. 2.7-2.8, DASA.

[12] Chart, Proj 48 Expenses Estimated by Months to Nearest $5,000, in MDH, Bk. 5, Vol. 2, App. B11, DASA.

[13] Chart, Lab Personnel by Months (UCRL), in MDH, Bk. 5, Vol. 2, App. B2, DASA.

In providing personnel, security, and other administrative services for the research staff, the area engineer dealt with teams of scientists and technicians organized along functional lines under three broad areas of investigation. The physics division, by far the largest, worked on the experimental calutrons, vacuum problems, mechanical and electrical design, reassembly of equipment, and fundamental physical research. The chemistry division, much smaller, investigated problems of preparing feed material for the calutrons and recovery and purification of their output of U-235 and ordinary uranium. The biological group constituted a subsidiary element of the Manhattan District's medical research program that had its headquarters at the Metallurgical Laboratory in Chicago. The area engineer provided its director with administrative support in coordinating the activities of his group with Lawrence's program, based upon primary guidance from the Chicago medical scientists. The Army was helpful, too, in assisting the laboratory in recruitment and maintenance of a staff of several hundred technicians and skilled workmen, who supported the work of the scientists and engineers.

Adding to the complexity of administering the Radiation Laboratory were the periodic influxes of scientific, engineering, and other technical delegations not only from the major American contractors but also those from abroad. Such firms as the Stone and Webster Engineering Corporation, Westinghouse Electric and Manufacturing Company, and especially the Tennessee Eastman Corporation sent their personnel to Berkeley to assist in plant development, or for orientation and training in the electromagnetic process. And in November 1943, Australian physicist Marcus L. E. Oliphant, who had played a significant role in the development of radar, and thirty of the British scientists who had come to the United States to aid in the atomic project were assigned to the laboratory—some until the end of the war—to work on various aspects of electromagnetic research.

The arrival and processing of each of these groups presented special problems to the area engineer in security and safety, to the laboratory business manager in personnel and finance, and to the laboratory director in program and staff coordination. These problems were further multiplied and magnified by their high turnover rate, the result of the project's need for scientific expertise at other facilities. As early as 1943, the Army had begun to send many of the contractors' specialists to the Clinton Works to assist Tennessee Eastman in preparing to operate the electromagnetic plant. The area engineer's staff facilitated their transfer, eventually permanently reassigning a sizable number. Again, in September 1944, the staff oversaw the move of one-third of the British scientists to the Tennessee site.

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[14] Paragraphs on the Radiation Laboratory based on Rpt, Peterson, sub: Visit to Berkeley Proj, 17 Oct 42, Admin Files, Gen Corresp, 680.2 (Berkeley), MDR; Directory of Personnel, MD and Univ of Calif Personnel of R & D Group, 20 May 43, SFOO; Rpt, sub: R & D at Univ of Calif Rad Lab, 24 Apr 45, pp. 30–46, SFOO; MDH, Bk. 5, Vol. 2, pp. 5.2–5.4, and Vol. 3, pp. 5.1–5.3 and App. B5 (Org Chart, Univ of Calif Lab Proj), DASA; Interv, Author with Reynolds, 6 Jul 64, CMH; Visitors Permits [Rad Lab], Oct 43 through 1946, Visitors Info File, SFOO; Fidler Interv, 6 Jul 64, CMH; Min, Coordination Committee Mtgs, Oct 42–Mar 44, Admin Files, Gen Corresp, 337 (Mtgs and Confs–Univ of Calif), MDR; Hewlett and Anderson, *New World*, p. 150.

For the most part, the area engineer's staff was not directly involved in the many meetings of committee and group leaders who planned research, assessed the results of experimental work, and advised on reassignment of technical and scientific personnel. But the area engineer and other Manhattan representatives did participate in one key group, the Coordination Committee. Business and scientific leaders of the laboratory and representatives of the major contracting firms attended the weekly meetings of this committee, which Lawrence had established to ensure coordination of effort between his program and the many outside organizations collaborating on design and construction of the electromagnetic production plant. After each session Captain Fidler, who had extensive training and experience in both engineering and science, prepared a written report of the entire proceedings to keep General Groves, and other District personnel, up to date on the progress of research and development activities at Berkeley. Whenever Groves visited the laboratory, usually once a month during the crucial period from October 1942 to November 1943, Lawrence convened the weekly committee meeting to coincide with the commander's itinerary. Feeling that the meetings provided an excellent means of communication with the key members of the laboratory staff, Groves took an active role in the free-for-all discussions of electromagnetic problems.

The area engineer's staff also carried on a number of other activities, most of them of a routine character. It took part in the negotiation and interpretation of contracts and the review of fiscal plans and policies; assisted in those aspects of personnel administration involving military problems, especially the obtaining of deferments for key scientific and technical employees; expedited procurement of equipment and materials, particularly those in scarce supply; and supervised the more ordinary aspects of security. For example, to avoid any possibility of revealing the connection of the University of California with the Army and the atomic project, Groves always conducted his inspections of the laboratory in civilian clothes. When he arrived at the San Francisco airport, Fidler met Groves clandestinely and whisked him off to his own house so that the general could change from military into civilian attire before going to the university.

Even the remarkably smooth course of the collaboration between the University of California, Berkeley, and the Manhattan District—a testimony to the success of Captain Fidler's liaison efforts, Groves's strenuous endeavors to keep himself fully informed, and Lawrence's exceptional administrative capabilities—on occasion was punctuated with a few problems, primarily because the university administration had to accept Manhattan's substantial requirements largely on faith for reasons of security. In mid-January 1943, sensing a disruption to normal university activities, William J. Norton, the university business manager, complained to Groves in no uncertain terms: "To date I have not seen the scratch of a pen—one written word setting forth the suggestions or directives of the government representatives in regard to the conduct of the Radiation Laboratories on the Berkeley campus. . . ." Noting that he was aware that in the past half year several Army officers, including Groves, had visited the campus, Norton continued that "invariably, after one of these visits, . . . [my] office is deluged with requests by numerous persons for more office space, laboratory space, entire buildings, shops, more guards, more of this and that—all in the name of the General or the colonel, or the captain who has just visited the various plants. But for some reason I am never in on the discussions at the start." Norton then assured Groves that he wished to have the project run smoothly, an objective that could be much more easily achieved, he said, if the general would only let him know the importance of the project and who on the campus officially represented the Manhattan District.[15]

Groves wrote to University of California President Robert G. Sproul, carefully explaining the reasons for the secrecy of the project and for the complicated and sometimes confusing relationships that existed between the Army, the university, and the contracting firms. He then outlined briefly the anticipated requirements for further space in university buildings. "Captain Fidler has been instructed," he stated, "to keep you [President Sproul] fully informed . . . at all times" concerning the physical needs of the project.[16] Groves also had requested that the War Department explain to Sproul the importance of the work in progress at the Radiation Laboratory. "[Its] energetic prosecution . . . ," Secretary of War Stimson wrote, "is a vital military necessity, for it is one of the foundation stones of an extremely important, probably the most important, development project in our war activities." [17]

Not all basic research for the electromagnetic process was done under the University of California contract. In June 1943, District representatives arranged with Tennessee Eastman to carry out research on certain aspects of process chemistry, using laboratory facilities (leased from Eastman Kodak) in Rochester, New York, and at the plant site in Tennessee. Cost of these research contracts, as well as those for process improvement in 1944 with Johns Hopkins and Purdue Universities, were small by comparison with the expenditures at the University of California, totaling considerably less than $2 million.[18]

Design and Engineering, 1943–1945

At its 25 June 1942 meeting, the S–1 Executive Committee decided that Stone and Webster would have primary responsibility for basic design and engineering of both buildings

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[15] Ltr, Norton to Groves, 14 Jan 43, Admin Files, Gen Corresp, 161 (Univ of Calif), MDR.

[16] Ltr, Groves to Sproul, 27 Jan 43, Tab 2, Historical Summary of Contract W-7405-eng-48, SF00.

[17] Ltrs, Stimson to Sproul, 27 Jan 43, and Groves to Fidler, 8 Feb 43, Tab 2, Historical Summary of Contract W-7405-eng-48, SF00.

[18] MDH, Bk. 5, Vol. 2, pp. 1.1, 2.5–2.10, Apps. B4, B6–B9, B12–B15, DASA; Hewlett and Anderson, *New World*, p. 158.

TABLE 1—STONE AND WEBSTER ENGINEERING AND DESIGN PERSONNEL

Date	At Boston	At Berkeley	In the Field[a]	Total
1 January 1943	239	29	9	277
1 July 1943	738	19	13	770
1 January 1944	743	13	33	789
1 July 1944	685	8	79	772
1 January 1945	463	8	49	520
1 July 1945	338	3	40	381

[a] Clinton and elsewhere.

Source: MDH, Bk. 5, Vol. 3, "Design," p. 3.52.

and equipment at the Tennessee site.[19] For security, the company formed a separate design organization, which by mid-1944 had nearly 750 employees occupying thirteen floors in four buildings in Boston and, in addition, a subordinate unit at the Berkeley campus and a liaison office at the Tennessee site (*Table 1*).

To monitor the Stone and Webster design group, the district engineer established in August 1942 the Boston Area Engineers Office and assigned Maj. Benjamin K. Hough, Jr., to head a relatively small staff. From the beginning, one of Major Hough's most important responsibilities was to ensure that the Stone and Webster design group functioned under maximum security conditions. The special group thus worked separately from other company employees, and overall knowledge of the electromagnetic project was limited to a few key officials and to August C. Klein, the company's chief mechanical engineer and newly appointed project engineer for the electromagnetic plant. The area engineer's staff also assisted the company in developing special security control measures in distribution of thousands of drawings to General Electric, Westinghouse, and other firms providing equipment and materials. The designs reflected the emphasis on security and speed in every phase of development. Wherever feasible, Stone and Webster designers planned to use standard items of equipment and customary methods of construction, primarily to save time. There was, however, a limit to the extent that standardization would be possible because of the special character of the processes; the need for exceptionally close tolerances and performance capabilities; and, as proven by experience, inevitable changes in equipment design.[20]

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[19] In addition to the main production facilities, Stone and Webster also designed most of the electromagnetic plant auxiliary, service, and support facilities—including experimental racetracks to train plant operators, shops, steam plants, a foundry, warehouses, cafeterias, and community utilities.

[20] Cert of Audit MDE 177-46, Boston Area, 26 Apr 46, Fiscal and Audit Files, Cert of Audit Registers, MDR; Org Charts, U.S. Engrs Office, MD, 15 Aug 43, 28 Aug and 10 Nov 44, Admin Files, Gen Corresp, 020 (MED–Org), MDR; List of

Continued

By the turn of the year, Lawrence and his staff at the Radiation Laboratory had made significant progress not only in their electromagnetic research but also in the areas of preliminary design and engineering of plant facilities, the results of which they forwarded to Stone and Webster. But before design of the plant could proceed very far, company engineers needed answers to two important questions: How rich in U-235 must the final product be and would a single-stage electromagnetic plant achieve that degree of enrichment? On 4 January 1943, Oppenheimer furnished Lawrence with a tentative answer. The goal, he wrote Lawrence, must be near-perfect separation, that is, production of practically pure U-235 as the final product. Any lesser enrichment, Oppenheimer believed, would require such a large amount of the very heavy uranium that its weight would make it unacceptable for a weapon.[21] The degree of enrichment possible with a single-stage plant was not definitely known, but it would not be enough to meet such stringent standards. A second-stage facility might take uranium processed in the original 500-tank plant and bring it to the required higher degree of enrichment.

At the Coordination Committee meeting in early February, Lawrence expressed the view that design of the second-stage might reasonably be delayed for another two months, pending receipt of data on the degree of enrichment attained in the experimental XA calutrons nearing completion at Berkeley. If this data indicated eventual achievement of 70- to 80-percent enrichment, no second stage would be necessary. Groves disagreed. There always had been the possibility that the electromagnetic process would be coordinated with some other isotopic separation process (he probably had in mind the gaseous diffusion plant), and he believed the second-stage facility would be necessary either as a supplement to the first stage of the electromagnetic plant or as part of a plant for enhancing the slightly enriched product from another plant.

As Groves departed from Berkeley on 14 February, he urged that prompt decision should be reached on the Beta process, as it now came to be called to distinguish it from the first stage, or Alpha process. The Radiation Laboratory staff had convinced him that the Beta tanks could probably be designed to make maximum use of Alpha-type equipment, but he needed further assurance from Stone and Webster that a second stage would not delay completion of the first stage.

General Groves and Colonel Marshall conferred with Stone and Webster on 17 March. Marshall took the initiative in securing a firm agreement that the first five Alpha racetracks at the Clinton Engineer Works (CEW) would be identical in design and

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Key Personnel, MD Area Offices (ca. Nov 44), Admin Files, Gen Corresp, 231.001 (LC), MDR; MDH, Bk. 5, Vol. 3, pp. 3.51-3.52, DASA; Tables (Employment by MD on Design, Research and Constr as of 31 May, 31 Jul, and 31 Oct 43) in Rpt, sub: MD Proj Data as of 1 Jun 43 (most items as of 1 Jun 43, but tables appear to have been added at later date), Admin Files, Gen Corresp, 600.12 (Projs and Prgms), MDR; Completion Rpt, Stone and Webster, sub: Clinton Engr Works, Contract W-7401-eng-13, 1946, p. 143, OROO.

[21] Ltr, Oppenheimer to Lawrence, 4 Jan 43, Admin Files, Gen Corresp, 201 (Lawrence), MDR.

equipment, to guarantee their completion at the earliest possible date. When the company assured Groves that Beta construction would not delay the Alpha units, he gave his approval for the second stage.[22]

By late spring, design development for both stages was in full swing. The Berkeley, Clinton, and Boston design staffs worked under constant pressure from Groves and other project leaders to produce thousands of blueprints for five Alpha and two Beta racetracks. The emphasis on speed took its toll. Frequently, General Electric, Westinghouse, and the other firms manufacturing components for the racetracks had to incorporate essential design changes after equipment was fabricated and installed, and inevitably some equipment failures occurred. Everyone connected with the electromagnetic project soon realized design, redesign, and process improvement would continue long after the first major units of the plant began production operations.[23]

By summer, with most blueprints for Alpha I completed and procurement contracts for plant equipment arranged, Groves approved design changes in the fifth Alpha I racetrack. In September, he authorized construction of Alpha II, comprised of four additional racetracks incorporating the improved design (a step recommended earlier by the Military Policy Committee). He also approved two more Beta racetracks, to process the additional output from Alpha II.

Thanks to experience gained on the Alpha racetracks, design of the Beta racetracks posed fewer problems. Beta chemical equipment, however, was quite a different story, because of the small quantities of material undergoing processing and the fantastically high value of U–235. To prevent even a minimum loss of output, the designers made the equipment as small as possible and used corrosion-resistant materials and special devices to recover the last traces of U–235.

With the start of plant construction, continuing design activities assumed a secondary role. Lawrence and his colleagues continued to propose innovations and design alterations in the racetracks, but General Groves consistently followed a policy of approving only changes that clearly would speed up progress. Hence, Radiation Laboratory scientists, in 1944 and 1945, were relegated largely to the role of consultants to Stone and Webster, Tennessee Eastman, and the other contractors, assisting them to improve design and operation of the existing plant facilities.

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[22] Min, Coordination Committee Mtgs, 3 and 13 Feb 43, MDR; Excerpt from Memo, M. P. O'Brien (Rad Lab Ex Engr) to Fidler, 14 Feb 46, quoted in par. 1d of Memo, Fidler to Groves, sub: Initiation of Work on Y–12 Beta Process, 22 Oct 46, Admin Files, Gen Corresp, 319.1, MDR; Hewlett and Anderson, *New World*, pp. 151–52.

[23] This and following paragraphs on electromagnetic design based on MDH, Bk. 5, Vols. 2–3, DASA; Hewlett and Anderson, *New World*, pp. 149–67; Ltr, Lawrence to Groves, 14 Jun 43, Admin Files, Gen Corresp, 440.17 (Mfg-Prod-Fab), MDR; Lawrence to Groves, 3 Aug 43, Admin Files, Gen Corresp, 095 (TEC LC), MDR; Memo, Maj Wilbur E. Kelley (Y–12 Opns Div chief, CEW) to Lt Col E. H. Marsden (Ex Off, MD), sub: Summary of Y–12 Proj as of 9 Aug 43, same date, Admin Files, Gen Corresp, Misc File, MDR; Min, Coordination Committee Mtgs, 2, 9, 30 Sep and 17 Nov 43, MDR; MPC Min, 13 Aug 43, MDR; Rpt, sub: R & D at Univ at Calif Rad Lab, 24 Apr 45, pp. 17 and 23, SFOO; Dist Engr, Monthly Rpts on DSM Proj, Sep and Nov 43, OCG Files, Gen Corresp, MP Files, Fldr 28, Tab A, MDR.

Building the Electromagnetic Plant

Actual construction began in February 1943 on a tract of 825 acres located in Bear Creek Valley, some distance southwest of the rapidly growing community of Oak Ridge *(Map 3).* Project engineers had selected this location because they hoped the wooded ridges paralleling the valley would limit possible lethal effects of a major explosion or similar accident. There was more than ample room between ridges to permit adequate spacing of the numerous plant facilities that, at the height of plant operations, would include nine main process buildings and some two hundred auxiliary structures, comprising nearly 80 acres of floor space.[24]

Construction Procurement

Stone and Webster had primary responsibility for procuring the materials, equipment, and field construction force needed for building the production plant; however, the Army had directed that the firm consult regularly with the Radiation Laboratory and with the major manufacturing contractors in carrying out materials and equipment procurement.[25] Both Stone and Webster and Manhattan officials had agreed that, because of the special nature of much of the equipment required for the electromagnetic process, only the leading manufacturing firms in the electrical equipment field were likely to have the resources and capabilities necessary to supply it. Consequently, in early 1943 Stone and Webster, with considerable assistance from District officials, negotiated subcontracts with General Electric, Westinghouse, Allis-Chalmers, and several smaller firms to design and manufacture such items as regulators, rectifiers, calutron tanks, diffusion pumps, magnet coils, and vacuum valves that would meet the project's high standards for workmanship and performance and, at the same time, comply with its stringent procurement deadlines.[26]

As Stone and Webster negotiated contracts, it also developed an elaborate purchasing organization at its Boston office. This organization worked closely with the Boston Area Engineers Office and, through a procurement unit established at the Tennessee site, with the CEW Construction Division. In addition to the 150 persons employed in Boston and Tennessee, Stone and Webster maintained another 250 representatives in the field at contractor plants and in major industrial areas. These field workers checked equipment for conformity to specifications, expedited deliveries, and assisted in locating scarce materials for subcontractors. Stone and Webster's procurement organization also worked closely with the Washington Liaison Office, especially in obtaining critical materials,

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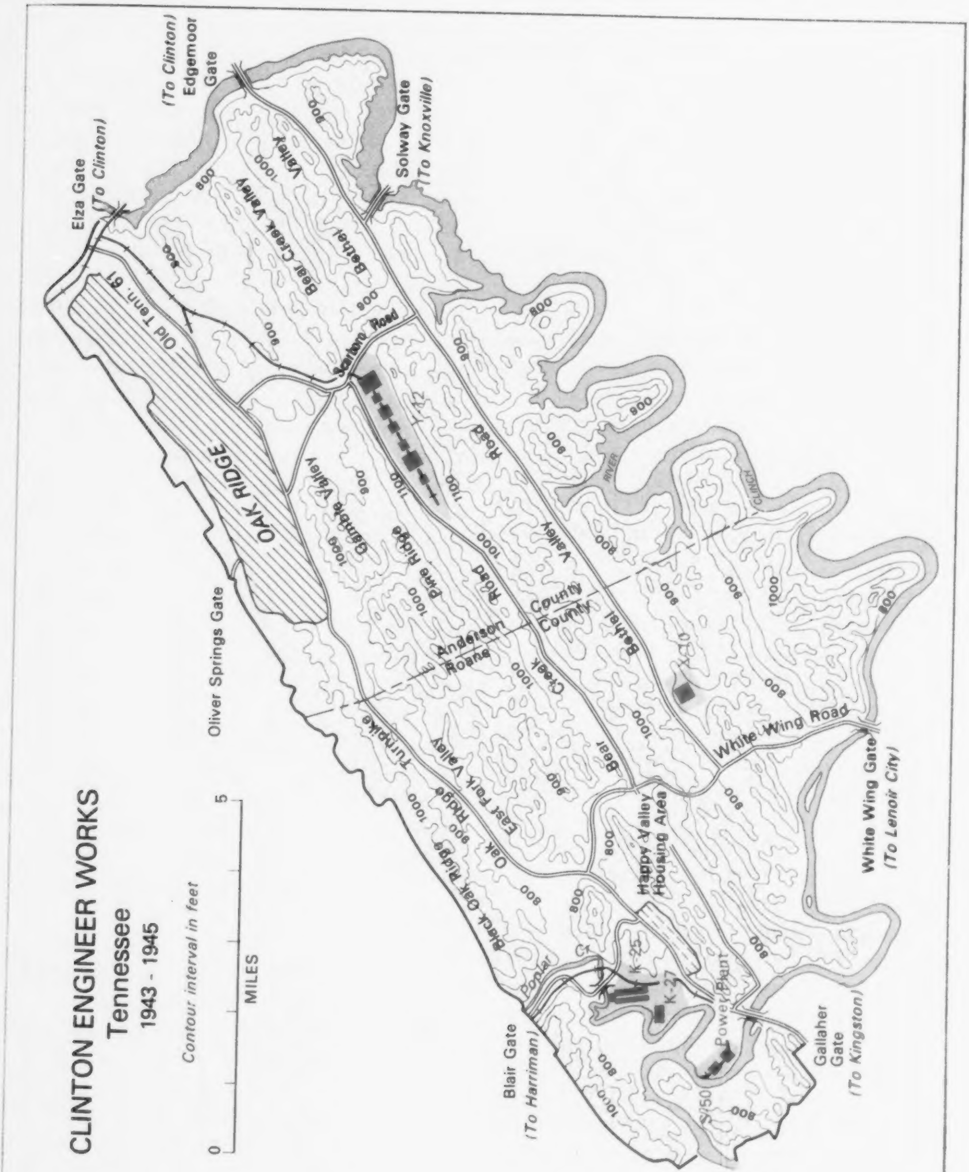
[24] A detailed discussion of most aspects of electromagnetic plant construction may be found in MDH, Bk. 5, Vol. 5, "Construction," DASA.

[25] A detailed discussion of the procurement of manpower for the electromagnetic project appears in Ch. XVI.

[26] Subsection based on MDH, Bk. 5, Vol. 2, pp. 3.3, 3.9, 4.6, Vol. 3, pp. 4.1 and 4.3–4.24, and Vol. 5, pp. 6.1–6.2, DASA; Completion Rpt, Stone and Webster, sub: CEW, Contract W-7401-eng-13, 1946, pp. 19, 21–23, 146–48, OROO; Org Charts, U.S. Engrs Office, MD, 15 Aug and 1 Nov 43, MDR; Fine and Remington, *Corps of Engineers: Construction,* p. 678; Min, Coordination Committee Mtgs, 23 Dec 42 and 23 Jan, 6 and 13 Feb, 29 Apr, 21 Oct 43, MDR.


CLINTON ENGINEER WORKS
Tennessee
1943 - 1945
Contour interval in feet
0
5
MILES
Elza Gate
(To Clinton)
Edgemoor Gate
(To Clinton)
Solway Gate
(To Knoxville)
Oliver Springs Gate
White Wing Gate
(To Lenoir City)
Gallaher Gate
(To Kingston)
Blair Gate
(To Harriman)
OAK RIDGE
Old Tenn. 61
Scarboro Road
Bear Creek Valley
Bethel Valley
Bethel Valley Road
Gamble Valley
Pine Ridge
Bear Creek Road
Anderson County
Roane County
East Fork Valley
Oak Ridge Turnpike
Black Oak Ridge
White Wing Road
Happy Valley Housing Area
Poplar Cr.
K-25
K-27
Power Plant
S-50
X-10
Y-12
CLINCH RIVER
800
900
1000
1100

MAP 3

on which it achieved an excellent record of placing most orders within a few days of construction authorization. Maj. Wilbur E. Kelley, a young engineer from Indiana who was responsible for overseeing electromagnetic activities for the Manhattan District, and Lt. Col. Warren George, head of the CEW Construction Division, also kept a watchful eye on procurement. (*See Chart 2.*)

The sheer quantity and variety of materials and equipment that rolled in by the trainload over a recently built spur track to the construction site taxed the monitoring capabilities of the CEW Construction Division. Starting in the spring of 1943, the builders of the plant moved into the site more than 2,157 carloads of electrical equipment; 1,219 of heavy equipment; 5,389 of lumber; 1,407 of pipe and fittings; 1,188 of steel; 257 of valves of all sizes; and 11 of welding electrodes. The Construction Division was responsible for seeing that all of this material was brought to the site as nearly on schedule as possible. If items arrived early, the division had to help find storage space—not always an easy task because of limited warehousing facilities.

Because parts and machinery could not be fabricated on schedules that dovetailed precisely with construction progress, much had to be accepted as the manufacturers were able to turn it out. Those items that arrived ahead of schedule had to be closely guarded; protected from dirt, corrosion, and other kinds of damage; and carefully inventoried so that they would be immediately available as needed. Chemical equipment posed problems because of special manufacturing and handling requirements, and the equipment often arrived late or just barely on time.

Schedules had to be adapted to last-minute changes in design and to many uncertainties. Discouragingly few items were commercially available. Tanks, magnets, vacuum pumps, cubicles, and most of the chemical equipment, for example, were either completely new in design or so much larger or so much greater in capacity that nothing of the kind previously had been manufactured. Many less obvious items also carried performance specifications that far exceeded anything ever attempted on a commercial scale. For instance, the calutrons required electrical cable that could carry a high-voltage load continuously. The only commercial product that came near meeting this specification was the heaviest X-ray cable, and it was designed to operate intermittently. Even when the commercial equipment could be used, suppliers often had to add to their productive capacity or build entire new plants to furnish the items required in the enormous quantities they were needed. Thus, in the first equipping of the racetracks some eighty-five thousand vacuum tubes were required. In the case of one type of tube, procurement officials ordered in advance the entire national output for 1943 as well as that from a plant still under construction. In the early months of plant operation, when tubes burned out faster than predicted, some feared the racetracks might prove inoperable simply through inability to maintain the tube supply.

New methods had to be developed for machining and shaping the graphite in those parts of the calutron subject to intense heat. No standard material would endure the high potentials, mechanical strain, and temperature changes to which bushings in the high-voltage elements in the sources were continuously subjected. After months of investigation, Stone and Webster found an insulator made of zirconium oxide, a new and still very expensive substance. Similarly, use of large quantities of liquid nitrogen to condense moisture created a demand for a substance hitherto not produced on a commercial scale anywhere in the country.

Nowhere were Manhattan District personnel more spectacularly involved in procurement than in the project's need for vast amounts of silver.[27] Because copper was in great demand for all kinds of wartime uses and because silver could serve as a substitute in electrical equipment, Colonel Marshall in the summer of 1942 had detailed Nichols to negotiate an agreement with the Treasury for withdrawal of silver from the United States Bullion Depository in West Point, New York.

District officials arranged to have the silver processed through the Defense Plant Corporation, which was conducting a silver program of its own in connection with other war industries. The silver, in 1,000-ounce bars, was moved by guarded truck to Carteret, New Jersey, where it was cast into billets, and then to Bayway, New Jersey, where it was extruded into strips ⅝'s of an inch thick, 3 inches wide, and 40 to 50 feet long. From Bayway, under the protection of Manhattan District guards, the coiled strips were moved by rail freight to the Allis-Chalmers plant in Milwaukee. There, some 258 carloads of silver were fabricated into coils and bus bars, then sealed into welded casings, and finally shipped on open, unguarded flatcars, by various routes and on irregular schedules, to the Clinton Works.

A central control section in the New York Area Engineers Office administered the silver program, but as a double check the District retained the services of a firm of auditors and a metallurgical concern. Some precautions taken to avoid unnecessary loss included weighing the silver each time it entered or left one of the plants, storing the pieces in stacks that would permit minimum handling during each eight-hour accountability check, and painstakingly collecting the scrap—even the minute amounts that might accumulate on a worker's clothing or shoe soles.[28]

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[27] Paragraphs on silver procurement based on MDH, Bk. 5, Vol. 4, "Silver Program," DASA. For details on Nichols's role in the silver negotiations, see Ch. III. Groves presents a good, brief account in his own book *Now It Can Be Told*, pp. 107–09. District officials had to account for and protect nearly one-third billion dollars of silver ultimately withdrawn from the Treasury for the use in the electromagnetic plant.

[28] When the time came to return the silver to the Treasury after the war was over, Manhattan District workmen disassembled and cleaned part by part the machines where it had been used, dismantled the furnaces in which it had been melted, and even took up the burned wooden floors to recover every trace possible. As a result, in the final accounting, less than one thirty-six-thousandth of 1 percent of the more than 14,700 tons borrowed by the District for the atomic project was missing, most of which was an unavoidable melt loss. See MDH, Bk. 5, Vol. 4, pp. 4.1–4.5, DASA; Groves, *Now It Can Be Told*, p. 109; Hewlett and Anderson, *New World*, p. 153.

Plant Construction

As work crews began excavating building sites and laying foundations early in the summer of 1943, Stone and Webster foremen knew plant construction must move ahead with maximum speed during the prime summer building season, to meet the extremely short deadlines projected by the Army. Reluctantly, Stone and Webster officials agreed to have the first Alpha racetrack building ready to turn over to Tennessee Eastman, the plant operator, by November and the remaining Alpha units at approximately monthly intervals thereafter. Project leaders were convinced that only adherence to this rigorous schedule would produce sufficient fissionable materials to fulfill the requirements for design and fabrication of an atomic weapon in time to affect the outcome of the war.

Stone and Webster had little difficulty in maintaining force-draft construction schedules for the plant buildings, mainly designed along the lines of structures in common use by industry. The only unexpected delay was the discovery of unfavorable subsoil conditions; excavation crews thus had to do some extra blasting and mucking and laying of 6-foot-thick concrete mats to ensure firm foundations for the enormously heavy electromagnetic machines. Through use of more thorough soil-sampling techniques, Stone and Webster was able to minimize the time lost in providing adequate footings for the later racetrack buildings.

Internal construction of the plant, however, was characterized by unconventional methods and unorthodox problems that seemed certain to cause delays and setbacks in working schedules. Project leaders had anticipated some problems. They knew, for example, that installing equipment while the building shells were under construction was likely to lead to complications because riggers, pipe fitters, and mechanics were not ordinarily accustomed to working elbow to elbow with concrete pourers, form builders, and other building construction workers. Also, security measures and the need to maintain extreme cleanliness in certain areas would require guards and a pass system to limit access to some parts of the buildings. And they well understood that assembling the complex racetrack and other production units involved demanding and time-consuming measures.[29]

Consequently, Manhattan District officials were pleasantly surprised when Colonel Nichols, who had replaced Marshall as district engineer, reported to General Groves in September that the electromagnetic construction was about 34 percent completed, including the turnover to Tennessee Eastman of the first operational facilities. These were the two tanks and three magnet coils of the XAX development plant with auxiliary supporting units to be used for training production plant workers. At the same time, Colonel Nichols noted that construction on the crucial main Alpha equipment was no more than a few weeks behind the ambitious schedules set up by Groves earlier in the year. Stone and Webster engineers had reported to him that they

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[29] MDH, Bk. 5, Vol. 5, pp. 3.1 and 3.9–3.10, DASA.

EXCAVATION OF TYPICAL ROCKY SUBSTRATUM AT THE TENNESSEE SITE

expected the first Alpha racetrack to be operational by 1 December 1943. The only disquieting note in Nichols's optimistic September estimate was mention of discovery of some "bugs" when the XAX tanks underwent their initial test operation.[30]

Partly on the basis of this impressive progress, General Groves authorized start of work on four of the improved Alpha II–type racetracks and two additional Beta units in September. Stone and Webster organized a whole new field force and the district engineer reorganized the CEW Construction Division, enlarging its personnel and establishing separate construction divisions to monitor the three major building projects in progress at the Tennessee site: the electromagnetic, gaseous diffusion, and plutonium semiworks facilities. Colonel George continued as head of the newly formed Electromagnetic Construction Division, but with additional officers assigned to branches to monitor Stone and Webster's nine construction subunits and a special expediting section. Thus, as Stone and Webster's engineers prepared to carry out a test run of the nearly completed Alpha I unit, District officials were confident that the electromagnetic project was well on the way to successful completion. Had they taken more careful note of the "bugs" that persisted in the XAX calutron test operations, they might have been better

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[30] Dist Engr, Monthly Rpt on DSM Proj, Sep 43, MDR; MDH, Bk. 5, Vol. 5, p. 3.16 and App. D11 (Chart, Employees on Stone and Webster's Payroll), DASA; Memo, Kelley to Marsden, sub: Summary of Y–12 Proj as of 9 Aug 43, same date, MDR.

prepared for setbacks the project was to suffer in the months ahead.[31]

The first of the unanticipated problems with the newly completed Alpha I racetrack was reported to Colonel Nichols in early November. A few days after they had started test runs, plant engineers discovered that the 14-ton calutron tanks, which stood back to back between the coils, had moved apart as much as 3 inches, causing a tremendous strain on the piping used to maintain a vacuum in the tanks. After investigation they determined that the powerful magnetic field set up in the racetrack had created such a force between the tanks that they "walked" away from each other when they were jarred, as during installation or removal of a door. Following a few days study of the phenomenon, Stone and Webster reported that the adverse effects of the magnetic field could be overcome by installing heavy steel tie straps to hold the tanks firmly in place.[32]

No such simple solution was possible, however, for the second major problem that the November test operations revealed. The symptoms were intermittent electrical shorts with wide fluctuations in magnetic field strength as successive magnet coils were energized. Colonel Nichols reported the problem to General Groves in early December, by which time the complete failure of several coils seemed to threaten the whole future of the process. Plant engineers indicated that dirt in the oil coolant inside the coils was probably the major cause of the malfunction and the only sure cure was to drain the oil and dry out the coils. Very much upset by the ominous developments, the Manhattan commander directed Nichols to take all measures necessary, pending his own arrival at the site to discuss such other steps as might be required, including "a reorganization of personnel in charge of the Y-12 [electromagnetic] construction work so that similar occurrences [would] be avoided in the future." [33]

Groves arrived at the Clinton Works on 14 December for a hurried two-day inspection visit. On hand already were project engineer August Klein from Stone and Webster and a team of experts from Allis-Chalmers, where the unsatisfactory coils had been manufactured. Their further checking, Groves learned, had revealed that the trouble stemmed not only from mill scale and rust in the cooling oil but also from moisture in the cloth and fiberboard insulation, and too close winding of wire. Groves set in motion a thorough reorganization of the Clinton electromagnetic administrative team and reemphasized his earlier directive to Lawrence that he concentrate Radiation Laboratory resources on finding a solution for the defects in the racetrack equipment.[34]

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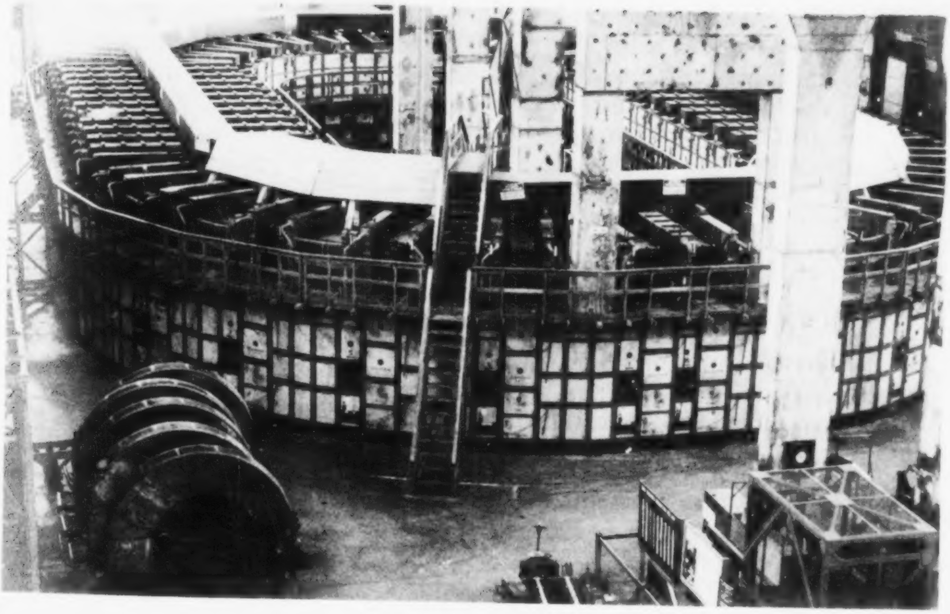
[31] Org Charts, U.S. Engrs Office, MD, 15 Aug and 1 Nov 43, MDR; MDH, Bk. 5, Vol. 5, pp. 6.1–6.4 and Apps. D7 and D10, DASA.

[32] Min, Coordination Committee Mtg, 11 Nov 43, MDR; Dist Engr, Monthly Rpt on DSM Proj, Nov–Dec 43, MDR.

[33] Msgs, Nichols to Groves and reply, 6 Dec 43, Admin Files, Gen Corresp, 412.41 (Motors), MDR.

[34] Msg, Nichols to Groves (at Hanford), 6 Dec 43; Msg, Lt Col Thomas T. Crenshaw (Ex Off, CEW) to Groves, [probably 7 or 8 Dec 43]; Memo, Peterson to Groves, 9 Dec 43. All in Admin Files, Gen Corresp, 412.41 (Motors), MDR. MDH, Bk. 5, Vol. 5, pp. 3.10–3.11, DASA. Groves Diary, 14–15 Dec 43, LRG.



Alpha I Racetrack, Electromagnetic Plant, CEW

A new administrative hierarchy resulted from the reorganization of the eletromagnetic team, which took effect in January 1944. Lt. Col. John S. Hodgson, who had considerable experience as a civilian contractor, replaced Colonel George as chief of the Electromagnetic Construction Division; Maj. William A. Bonnett moved up from a position as a liaison officer with Stone and Webster field units to be Hodgson's assistant; and Maj. Walter J. Williams, who had had assignments on a number of ordnance plant construction projects, took over responsibility for completion of the original electromagnetic plant. Only Maj. Mark C. Fox, who had served as area engineer on other Corps of Engineers projects, continued in his recently assigned task of overseeing construction of extensions to the original electromagnetic plant. At the same time, Stone and Webster brought in Frank R. Creedon from the synthetic rubber progam to be general manager of all the company's operations at the Clinton Works. Creedon had had an earlier association with General Groves, having worked as a civilian employee of the Army's Construction Division on ordnance projects before 1942.

The first big task facing the new team was how to solve the technical defects in the Alpha I electrical equipment. Project technicians decided the only sure remedy was to return the malfunctioning magnet coils to Allis-Chalmers' Milwaukee plant for cleaning and rewinding, as well as to have equipment crews disassemble and clean all oil lines in the racetrack building. It took about three months to complete these corrective measures, and thus the first Alpha I racetrack was not fully operative again until early March 1944.[35]

With the distressing days of technical problems in the past, by spring the somber mood of Manhattan and Stone and Webster officials concerning the electromagnetic method had dissipated, and they were enjoying a revived sense of optimism. One argument in favor of the process had been that the production plant could be built in segments which would become operational as soon as they were completed, making possible the early detection of defects and the addition of indicated improvements. And now, because the trying experiences of Stone and Webster engineers with the first Alpha I racetrack had enhanced their understanding of the problems and the reasons for them, they were able to make changes in equipment handling and installation techniques for subsequent racetracks. On the second Alpha I racetrack, for example, the engineers introduced much more rigid standards of cleanliness, including such measures as drying out pipe lines by circulating preheated oil through them and adding filters for each coil.[36]

Initial failure of Alpha I also reaffirmed a cardinal principle of General Groves's administrative policy for the atomic project. For months, the Manhattan commander had been emphasizing that the major resources and personnel at the atomic research laboratories should be concentrated on the single objective of securing production of militarily significant amounts of fissionable materials in time to be of use during the war. On more than one occasion during his visits to the Radiation Laboratory in the fall of 1943, Groves had reminded Lawrence's scientific staff that the Army was not interested in advancing pure science. Their mission, he stated, once the research and development for the production plant was completed, was to support in whatever way was necessary the design, construction, and operation of that plant. The natural tendency of the Radiation Laboratory scientists was to resist limiting themselves solely to so-called debugging activities for the Tennessee plant, but the crisis caused by Alpha I's failure forced Lawrence to push new research entirely into the background and, in December, to completely redefine laboratory priorities in terms of two objectives: increasing the output and efficiency of the electromagnetic plant; and developing new ideas, methods, and engineering designs for expanding that plant.[37]

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[35] Org Chart, U.S. Engrs Office, MD, 15 Feb 44, MDR; MDH, Bk. 5, Vol. 5, pp. 3.10–3.11 and 6.1, DASA; Fine and Remington, *Corps of Engineers: Construction*, pp. 684–86; Groves, *Now It Can be Told*, p. 102 and 427; Dist Engr, Monthly Rpt on DSM Proj, Mar 44, MDR.

[36] MDH, Bk. 5, Vol. 5, pp. 3.11, DASA; Memo, E. W. Seckendorff (Y-12 Process Engr) to T. R. Thornburg (Gen Supt, Y-12, Stone and Webster), sub: Detailed Method of Cleaning and Altering Pipe at Racetrack B-Bldg 9201-1, CEW, Area Y-12, 30 Dec 43, Incl to Memo, Crenshaw to Groves, 1 Jan 44, Admin Files, Gen Corresp, 337 (Kellex LC), MDR.

[37] Min, Coordination Committee Mtg, 17 Nov 43, MDR; Dist Engr, Monthly Rpt on DSM Proj, Nov–Dec 43 and Feb 44, MDR; Ltr, Lawrence to Nichols, 22 Mar 44, MDR.

The Army's prompt administrative measures to counter the adverse consequences of Alpha I's failure proved to be highly effective. The engineers were successful in making the second Alpha I operational by the end of January 1944, the first Beta and the first and third Alpha I in March, and the fourth Alpha I in April. Impressed with the rapid progress being achieved, Colonel Nichols reported to Groves that he was now convinced that the prediction given to President Roosevelt in December 1942—completion of an atomic weapon by early 1945—would be realized if persisting manpower shortages could be overcome.[38]

Meanwhile, Stone and Webster had been moving ahead with construction of other major elements of the electromagnetic plant. Construction time for building the extension units—the Alpha II racetracks—was far less in comparison to that required for Alpha I. The Stone and Webster crews' rapid progress was in part due to certain design modifications, such as using cement asbestos brick for the outer siding of buildings and making the racetrack shape rectangular rather than oval. Also, the experience gained on Alpha I expedited installation of equipment in Alpha II. The first racetrack in the extension plant began operating in July 1944 and all four were ready for operation by 1 October.[39]

At the same time, Stone and Webster and its subcontractors constructed the Beta units, where the Alpha-processed material would be further enriched, and built the facilities for chemical preparation and recovery for both Alpha and Beta plants. In spite of several changes in plans, resulting in considerable expansion of the Beta and chemical facilities, the Electromagnetic Construction Division kept the work on or even ahead of schedule, avoiding delays in processing material from the Alpha plants. From original plans in 1943 for only a single Beta unit to process Alpha I output, the number grew to four: one for Alpha II; another to handle additional output from Alphas I and II that resulted from using partially enriched feed material from the gaseous diffusion plant; and still another in 1945 so that there would be enough Beta facilities to process enriched material coming directly from the diffusion plants. Similarly, each expansion of the Alpha and Beta units required an increase in the number of chemical and other processing facilities, giving the division additional work in expediting procurement, monitoring revision in contracts, and inspecting completed construction. This continuing high-level of construction activity occasioned Colonel Hodgson to reorganize his division in late 1944 and to establish five separate branches (structures, electrical, expediting, process piping, and mechanical). Not until early 1945, when the Military Policy Committee decided that the indicated successful operation of the gaseous diffusion and plutonium plants would make further large-scale expansion of electromagnetic produc-

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[38] Dist Engr, Monthly Rpts on DSM Proj, Jan and Mar 44, MDR; Rpt, Nichols, sub: Info for Groves, 8 Apr 44, OCG Files, Gen Corresp, MP Files, Fldr 28, Tab A, MDR.

[39] MDH, Bk. 5, Vol. 5, pp. 3.17–3.20, 3.22, 5.2, DASA.

Electromagnetic Plant Under Construction

tion facilities unnecessary, did the division's workload ease significantly.[40]

Plant Operation

Terms of the June 1943 contract for operation of the electromagnetic plant provided that Tennessee Eastman operate it on a cost-plus-fixed-fee basis, serve as a consultant on plant design, obtain and train operating personnel, and carry on research to improve the process and its product. For performing these services, the government agreed to pay the firm a basic operating fee of $22,500 each month plus $7,500 for each racetrack up to seven and $4,000 for each one over that number.[41]

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[40] Ibid., pp. 3.13–3.15, 3.20–3.23, App. D6 (Tabulation of Bldg Statistics), DASA; Dist Engr, Monthly Rpts on DSM Proj, Oct 43 and Aug and Nov 44, MDR; MPC Min, 10 May 44 and 25 Feb 45, MDR; Completion Rpts, Stone and Webster, sub: CEW, Contract W–7401–eng–13, 1946, pp. 49–50, and Contract W–14–108–eng–60, 1946, pp. 6–8, OROO; Rpt, W. M. Brobeck and W. B. Reynolds, sub: On Future Development of Electromagnetic System of Tube Alloys Isotope Separation, 15 Jan 45, OCG Files, Gen Corresp, Groves Files, Fldr 10, MDR.

[41] WD Contract W–7401–eng–23, 7 Jun 43, with supps., OROO; MDH, Bk. 5, Vol. 6, "Operation," pp. 2.2–2.5 and 3.1–3.5, DASA.

Preparations

In early 1943, when Tennessee Eastman initiated preliminary operational activities at the Tennessee site and at the Berkeley and Rochester research facilities, the district engineer formed a CEW Division in the New York office and assigned Major Kelley as division chief to supervise electromagnetic operations. Kelley's division not only monitored the contractor's activities relating to administration, chemical processes, electrical processes and plants, and special accounts but also established liaison with its Berkeley and Boston administrative units that coordinated with the Radiation Laboratory and Stone and Webster. Tennessee Eastman's Boston staff, however, moved to the Tennessee site in August, in keeping with the firm's frequently expressed desire to center its plant operations activities there.[42]

During construction Major Kelley and his operating unit staff were busy assisting Tennessee Eastman in recruiting and training personnel to operate the Alpha, Beta, and chemical process equipment. Early estimates of the number of employees needed were far too low and requirements were repeatedly revised upward. Although recruiting was carried on in all sections of the country through regional offices of the United States Employment Service, the best results were attained in Knoxville and vicinity. For the many jobs requiring technical knowledge and background, the electromagnetic project had to resort to procurement through military channels. Many of the scientifically trained personnel in the Manhattan District's Special Engineer Detachment (SED) at the Clinton Works were assigned to work in the plant, reaching a total of 450 SED enlisted personnel by August 1945. The District also assisted in the temporary assignment of technically trained Navy officers to the plant in 1944, their number reaching a maximum of 143 in July of that year.[43]

Tennessee Eastman made a major effort to develop a training program for the thousands of operators who would be required when the plant was ready for full-scale operation. Working closely with Radiation Laboratory scientists, the firm's Berkeley staff laid the groundwork for systematic training of workers and supervisory personnel. While many practiced with the Alpha experimental equipment at Berkeley, others went to the University of California's Davis campus to learn chemical processing techniques. Radiation Laboratory scientists and Manhattan District representatives carefully reviewed all training material, the latter group giving special attention to the security problem. Tennessee Eastman technicians deliberately compiled the training material to give the would-be operator only the information needed to perform

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[42] Subsection based on Org Chart, U.S. Engrs Office, MD, 1 Nov 43, MDR; MDH, Bk. 5, Vol. 5, Sec. 3, and Vol. 6, pp. 3.3–3.5 and 8.1–8.3, DASA; Min, Coordination Committee Mtgs, 23 Jan, 6 Mar, and 24 Jun 43, MDR; Dist Engr, Monthly Rpts on DSM Proj, Sep 43 and Mar 44, MDR; Min, Special Progress Mtg, 5 Aug 43, Admin Files, Gen Corresp, 337 (Mtgs and Confs–Univ of Calif), MDR; Hewlett and Anderson, *New World*, p. 162; Rpt, F. T. Howard, sub: The DSM Proj, Synthetic Catalyst Div, 22 Apr 43, OCG Files, Gen Corresp, MP Files, Fldr 28, Tab A, MDR.

[43] For a more detailed account of manpower recruitment, and the SED's formation and organization, see Ch. XVI.

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the job, without revealing the true character or purpose of the end product. Experimentation demonstrated that trainees with preliminary orientation in the nature of the electromagnetic process made the most rapid progress. Meanwhile, by September 1943, intensive recruiting efforts by the company had resulted in the hiring of some eighteen hundred operator trainees, most of them from the Knoxville area.

Some preliminary instruction took place in facilities of the University of Tennessee, because the large-scale training program at the plant site did not start until early fall. By that time hundreds of trainees were on hand to begin training on two experimental XAX electromagnetic production tanks that had started operating in the development plant. Tennessee Eastman moved all but a few of its personnel from Berkeley to the Tennessee site to participate in training the twenty-five hundred operators deemed necessary for the five Alpha I racetracks. With the addition of the Alpha II and Beta buildings, the trainee program expanded to provide several times that many operators. By early 1944, Tennessee Eastman's payroll had increased to ten thousand and by mid-1945 it would rise to more than twenty-five thousand.

The typical operator trainee was a woman, recently graduated from a nearby Tennessee high school, with no scientific training whatsoever. Using one of the XAX electromagnetic tanks in the development plant, the instructional staff taught her how to operate complex control panels in the calutron cubicles adjacent to the racetracks. They gave her only information essential to her task as an operator and, for security reasons, actually mislead her as to the real purpose and character of the product. The training program was surprisingly successful, supplying operators on schedule for each Alpha and Beta racetrack as it went into operation.

Production Activities

Starting up in late 1943, the electromagnetic chemical units eventually were producing thousands of pounds of the charge material necessary for the production operation of the racetracks. The first really effective production of the U-235-enriched final product came in late January, when the second Alpha I racetrack began operating. In the five-month period following, as the remaining three Alpha I and the first two Beta tracks became fully operational, production steadily increased. And by mid-1944, the Army could view the electromagnetic start-up operations as, in the main, successful.[44]

Manhattan District officials, however, were unprepared for the almost continuous problems that arose as the electromagnetic plant moved into the sustained production phase of its operation. One mechanical or equipment failure after another plagued plant operations; short circuits and shortages, breakdowns and breakages cropped up on all sides. In spite of the best efforts of Tennessee Eastman and District procurement officials, the spare parts situation skirted the edge of chaos for months. Lack of experience, of standardization, and of a suf-

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[44] MDH, Bk. 5, Vol. 6, pp. 4.2 and 4.4–4.5, DASA; Dist Engr, Monthly Rpts on DSM Proj, Jan–Jun 44, passim, MDR.

CEW TRAINING FACILITIES *(background), where electromagnetic plant employees received preliminary instruction. District headquarters buildings are in the foreground.*

ficient number of suppliers all contributed to the severe parts procurement difficulties. Nevertheless, the District's electromagnetic staff and Tennessee Eastman—working in close coordination—managed sufficiently to overcome the adverse effects of these many problems so that in March 1944 plant workers shipped the first of several hundred grams of Alpha product, containing 13 to 15 percent U-235, to Los Alamos. Three months later the first shipment of the much more highly enriched Beta product reached the New Mexico laboratory.[45]

But Manhattan and Tennessee Eastman officials were well aware that this output of sample quantities represented only the first steps in bringing the electromagnetic plant up to a maximum rate of production, a complicated undertaking with pitfalls at every turn.[46] They readily perceived that part of the difficulty was inherent in the basic nature of the process that used large complex machines and significant quantities of electric power and raw materials to isolate an infinitesmally small amount of final product. The basic feed material, orange-colored uranium oxide shipped in from refineries operating under direction of Manhattan's Madison Square Area Engineers Office, moved through a series of very complex steps. A chemical preparation process converted it into a gaseous form, uranium tetrachloride, which plant work-

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[45] MDH, Bk. 5, Vol. 6, pp. 4.2 and 4.4–4.5, DASA; Memo, J. C. White (Gen Mgr, Tenn East) to Groves, 28 Jun 44, Admin Files, Gen Corresp, 095 (TEC), MDR.

[46] Paragraphs on electromagnetic plant operations based primarily on MDH, Bk. 5, Vol. 6, Sec. 4, DASA.

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ers then fed into the Alpha racetracks. Here part of the feed material separated, while the rest adhered to various parts of the interior of the calutron, where it had to be recovered for recycle. The separated portion went to the Beta chemical preparation stage and then into the Beta racetracks for further separation. That separated portion emerged as U-235 final product and, after concentration, workers shipped it to the Los Alamos Laboratory. The rest had to be recovered, recycled through the Beta racetracks, and concentrated for shipment.

Only 1 in 5,825 parts of charge material fed into the Alpha racetracks emerged as final product; 90 percent of the charge material was left in the feed bottles or scattered around the tanks. Of the 10 percent that passed into the ion beams, only a very small quantity entered the receivers. The amount reaching the receivers was limited by the capacity of the calutrons. It could not be increased except through use of enriched charge material, or by construction of more racetracks. Furthermore, the amount actually recovered from the receivers, because of its minute quantity and the essentially violent nature of the process, could not be made to reach 100 percent even by the most practicable methods.

Because of the high intrinsic value of the final product, recovery had to be as complete and thorough as possible, yet with no undue holdup time in the chemical apparatus to slow down the process. The Beta chemistry facilities included a salvage department which used batteries of extractors, reactors, filters, centrifuges, evaporators, and driers so that the very last traces of enriched uranium might be recovered. Justification for these intensive efforts was demonstrated when worn-out carbon receiver parts from the calutrons were burned. They yielded enough enriched uranium to raise the January 1945 production a full 10 percent.[47]

Even under the best of conditions, a small amount of U-235-enriched product always remained in solutions, or bound in solids, or adhered to costly and scarce equipment parts; however, it was economically unfeasible for this material to be recovered. A certain percentage also remained in that part of the uranium feed matter which passed through the ion beam but did not enter the receivers. It was imperative that this material—constituting nine-tenths of the uranium fed into the Alpha calutrons and seven-eighths of that going into the Beta racetracks—be prevented from contaminating the enriched uranium and be recovered and stored for possible future reprocessing. To keep losses at a minimum and to prevent theft, Tennessee Eastman instituted a strict material accounting system. Stock room employees inventoried the Alpha stocks every four weeks, the Beta every two weeks. In spite of this careful check, surprisingly large amounts of material (17.4 percent of Alpha product by September 1945 and 5.4 percent of Beta product by December 1946) were lost unavoidably in the various kinds of wastes created by the separation process itself.[48]

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[47] Memo, Kelley to Groves, sub: Present Status of Beta Chemistry Opns, 8 Sep 44, Admin Files, Gen Corresp, 600.1 (Constr CEW), MDR; Hewlett and Anderson, *New World*, pp. 295–96.

[48] Data concerning losses of feed materials and recovery problems is derived from MDH, Bk. 5, Vol.

Continued

The most crucial phase of the recovery operation took place in Beta chemistry. Alpha workers moved the final Alpha product, stored in receiver pockets on the removable doors of the Alpha calutrons, to the Beta chemistry buildings. After dismantling the pockets, Beta workers first scraped, bleached, and burned the graphite parts and then leached and electrostripped the metal parts. Finally, chemists processed the resulting solutions and solids to extract all enriched uranium. They then purified this enriched uranium and converted it into Beta feed material.

The Beta preparatory chemical process proved to be one of the most persistently troublesome operations in the electromagnetic plant. The process was slow, requiring, even under optimum conditions, about three weeks. More worrisome, however, only about 60 percent of the enriched uranium brought from Alpha was showing up as an end product of the Beta chemical process, causing a serious shortage of feed material for the Beta racetracks. In July 1944, Groves himself went to the Clinton Works to discuss the problem with plant and District officials. As a result, Tennessee Eastman temporarily shut down all Beta production in August so that company engineers and outside consultants could thoroughly analyze the process and equipment. Their investigations revealed that the trouble lay in the overly complex piping and equipment and in the tendency of certain materials in this equipment to absorb too much uranium.

District and Tennessee Eastman officials immediately instituted changes in equipment, techniques, and organization to overcome these weaknesses in Beta chemistry. Project engineers set about removing, cleaning, and redesigning piping; replaced glass-lined tubes with pyrex; put in more parts made of graphite from which absorbed uranium could be recovered by burning; and made other changes to speed up the process. For varying periods during the fall of 1944, experts like Frank H. Spedding, the metallurgist who headed Manhattan's research program at Iowa State College, and John P. Baxter, one of the British scientists assisting in the bomb development program, came to the Clinton Works to study Beta chemistry with an eye to improving techniques employed in the process. And, in December, District officials negotiated contracts with Johns Hopkins and Purdue Universities to study methods for increasing recovery and reducing holdup time in the Beta process. Tennessee Eastman, now more fully aware of the chemical difficulties of isotopic separation, completely reorganized its Clinton chemistry division and greatly increased the number of personnel.

In spite of the difficulties with Beta chemistry operations, in January 1945 the district engineer reported to the Manhattan commander that there had been a dramatic increase in Beta production during the second half of 1944, with output being about 60 percent greater at the close of December. This increase was attributable primarily to the much higher productive capacity of Alpha II calutrons, and the fact that all Alpha II's were

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6. pp. 4.16–4.17 and App. C (with illustrations), DASA.

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fully operational by November. Consequently, Beta output in November was more than ten times the July rate, increasing even more in December to twice the November rate. The Alpha II's, however, were far from trouble-free. The major problem experienced had to do with the insulators burning out at a high rate, but the engineers quickly corrected this defect by recommending that zircon be substituted for the less durable material in the bushings.[49]

Not all of the production problems of the electromagnetic project were mechanical or technical in nature. When the spare parts crisis occurred in June 1944, Groves looked into project management by Tennessee Eastman and District officials. Following a visit to the plant, he wrote to Conant that he had observed a number of ways in which he thought production might be increased. Supervisors ought to make more frequent inspections, especially in installation and servicing of calutrons. More should be done to build up and maintain employee morale. Lack of sufficient organization charts and the presence of "too many people" in the operating rooms gave Groves the impression that the plant managers were not making the most efficient use of personnel. Also, he wondered if Frederick R. Conklin, the Tennessee Eastman works manager, and Major Kelley, chief of the District's Electromagnetic Operations Division, were "too similar in disposition," noting that neither Conklin nor Kelley was a "hard driving, optimistic executive. Instead of setting an impossible goal and then breaking their hearts to almost achieve it, they set a nice, comfortable goal making plenty of allowances for difficulties and then feel very proud of themselves for having been proven right in their pessimistic outlook."[50]

General Groves took no immediate steps to institute major changes in management. He could not overlook the fact that Major Kelley got along extremely well with the key executives of Tennessee Eastman and also was held in very high regard by Lawrence and the staff of the Radiation Laboratory. It was not until September, with the spare parts problem partially relieved and the Beta chemistry bottleneck on the way to solution, that the Manhattan commander directed the district engineer to replace Kelley. Colonel Nichols selected Lt. Col. John R. Ruhoff, a chemical engineer by profession, because of his familiarity with electromagnetic problems; he had been assistant chief of the District's Materials Section and, since 1943, chief of the Madison Square Area Engineers Office where he was responsible for overseeing the provision of feed materials for the electromagnetic process. In early 1945, Ruhoff assumed responsibility for overseeing all electromagnetic activities at the Clinton Works and continued in that post until the end of the war. Major Kelley did not leave the

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[49] Memos for File, Kelley, sub: Notes on 3 and 14 Jul Confs, 4 and 15 Jul 44, Admin Files, Gen Corresp, 337 (LC), MDR; Memo, Kelley to Groves, sub: Present Status of Beta Chemistry Opns, 8 Sep 44, MDR; Dist Engr, Monthly Rpts on DSM Proj, Jul 44–Jan 45, passim, MDR; Hewlett and Anderson, *New World*, pp. 295–96; MDH, Bk. 5, Vol. 6, pp. 4.9–4.10 and 5.3, DASA.

[50] Ltr, Groves to Conant, 5 Jun 44, Admin Files, Gen Corresp, 400.17 (Mfg-Prod-Fab), MDR; Ltr, White to Groves, 28 Jun 44, Admin Files, Gen Corresp, 095 (TEC LC), MDR.

ELECTROMAGNETIC PLANT IN FULL OPERATION

Manhattan Project, but replaced Ruhoff as head of the Madison Square Office.[51]

Although there was a gradual, but not spectacular, improvement in electromagnetic production, intermittent expressions of dissatisfaction with the way the plant was operating continued. For example, British scientists working at the Radiation Laboratory came away from a visit to the plant highly critical of certain design features of process equipment and of the alleged gross inefficiency of the service crews. Marcus Oliphant, head of the British group, also found serious fault with personnel and organization. He wrote to Sir James Chadwick in November 1944, expressing concern at the "poor quality of the higher grade personnel in TEC [Tennessee Eastman Corporation] . . . [and] the clumsiness of the army organization, which neither controls nor checks the operation except in a very desultory and inefficient manner." [52]

Partially as a reaction to this continuing criticism, but chiefly as a reflection of frayed nerves under the long strain, Tennessee Eastman executives complained bitterly in April 1945 to Brig. Gen. Thomas F. Farrell, who had been serving as Groves's deputy since February, that the firm was not getting the recognition it deserved for what it had accomplished at the Clinton Works. Operation of the electromagnetic plant should be viewed for what it actually was, a huge pilot plant, not a normal industrial operation. While, undoubtedly, there were deficiencies that the firm could correct, there were also handicaps which it could not possibly overcome. The plant had been designed with few interchangeable parts; the damage to equipment had been greater than projected; and the program had been constantly changing, as in the case of the recent shifts to thermal and gaseous diffusion feed materials. In the light of all these mitigating factors, they were especially disturbed by the implication of General Groves's remark to the operating supervisors that "they should work until they fell into their graves just as the war was over." [53]

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[51] Ltr, Lawrence to Nichols, 12 Jul 44, Admin Files, Gen Corresp, 020 (MED-Org), MDR; MDH, Bk. 5, Vol. 6, p. 8.1, DASA.

[52] Ltr, Oliphant to Chadwick, 2 Nov 44, Admin Files, Gen Corresp, 201 (Chadwick, J), MDR; Baxter, Notes on Alpha and Beta Output, 6 Nov 44, Admin Files, Gen Corresp, 600.12 (Y-12), MDR. See also Interv, Author with Dr. Elkin Burckhardt (physicist, Y-12), CMH.

The criticisms and complaints began to lose some of their sting by late spring of 1945 as rapidly increasing production provided concrete evidence that the plant was going to be a success. In January, all the racetracks had demonstrated their ability to perform at predicted capacity, even though delays in servicing, chemistry, and procurement of parts still imposed a drag on full production. In February, the first slightly enriched (1.4 percent) uranium feed had come from the new thermal diffusion plant, and in March the first enhanced (5 percent and up) material from the gaseous diffusion plant. In April, the gaseous plant began turning out uranium sufficiently enriched to go directly into the Beta racetracks, gradually increasing product enrichment until it reached 23 percent on 5 August: the day before the first bomb was dropped on Japan.

Because of the higher enrichment of the Beta feed material, the Alpha stage was no longer necessary. In early September 1945, with the occupation of Japan going forward successfully, plant officials ordered the Alpha racetracks shut down. They had produced more than 88 kilograms of final product with average enrichment of 84.5 percent. Beta continued in operation until the end of the year, producing an additional 953 kilograms of final product with an enrichment of about 95 percent. [54]

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[53] Memo, Farrell to Groves, sub: Apr 18th Conf at Clinton, 19 Apr 45, Admin Files, Gen Corresp, 337 (CEW), MDR.

[54] MDH, Bk. 5, Vol. 6, pp. 4.13–4.14 and Top Secret App., DASA.

CHAPTER VII

The Gaseous Diffusion Process

By late 1942, atomic project leaders had authorized development of four technically and theoretically different processes—the electromagnetic, gaseous and liquid thermal diffusion, and gas centrifuge—as potential methods for producing sufficient U-235 of a quality to be militarily useful in World War II. Work on these processes had been in progress for about two years, long enough to make apparent the relative advantages and disadvantages of each.

Because no single method appeared capable by itself of producing the badly needed U-235, Manhattan leaders conceived the possibility of employing two or more of the processes in combination. They readily endorsed the electromagnetic as one of the methods; unlike the other three, it could begin producing adequately enriched U-235 from an only partially completed plant. Selection of the other process for full-scale development in tandem with the electromagnetic came in early December. The Lewis reviewing committee gave the gaseous diffusion process a solid endorsement, recommending construction of a 4,600-stage plant capable of producing 90 percent U-235 in substantial quantities. Meeting on the tenth, the Military Policy Committee then approved this recommendation, basing its decision upon the conclusion that even though project scientists had yet to satisfactorily design the key components for a gaseous diffusion plant, the process was, nevertheless, more likely to produce a sufficient quantity of fissionable material suitable for an atomic weapon than either the liquid thermal diffusion or centrifuge processes.[1]

Gaseous Diffusion Research and the Army, 1942–1943

Research and development on the diffusion process, which had started in 1940, centered at Columbia University under the direction of two members of the faculty, Harold C. Urey, an eminent physical chemist and Nobel Prize winner (1934), and John R. Dunning, a young physicist. Supported since 1941 by funds from the Navy and an OSRD contract, diffusion research by December 1942 had made substantial progress toward development of a large-scale expansion of the process. On the basis of a theory provided by Karl P. Cohen, a young mathematician on the Columbia staff, the Columbia research group had built Pilot Plant No. 1, a small twelve-stage apparatus, in the university's Pupin Hall. And operation of this unit in the fall of 1942 had furnished valuable data on the major elements of a diffusion plant, most significantly, the material for the barrier component that filtered the process gas in each separating stage.[2]

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[1] The Military Policy Committee approved continued but limited support for research and development of the liquid thermal diffusion and centrifuge processes. The detailed arguments for and against full-scale development of these processes may be found in Memo, Richard C. Tolman (Groves's scientific adviser) to Groves, sub: Visit to Centrifugal Plant at Bayway, N.J., 20 Dec 43, Admin Files, Gen Corresp, 201 (Tolman), MDR; Draft Rpt, Lt Col John R. Ruhoff, sub: Summary on Atomic Energy, 17 Jun 46, Admin Files, Gen Corresp, 600.12 (Atomic), MDR; MPC Min, 12 Nov and 10 Dec 42, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; MDH, Bk. 2, Vol. 3, "Design," pp. 3.1–3.2, DASA; Conclusions of Reviewing Committee, 4 Dec 42, Admin Files, Gen Corresp, 334 (Special Reviewing Committee), MDR; Ltr, Urey to Conant, 4 Sep 43, Admin Files, Gen Corresp, 201 (Urey), MDR. See also Chs. VI and VIII.

When the Army began taking over direction of the atomic bomb project in the summer of 1942, the Columbia diffusion research program continued to operate under OSRD contracts. Beginning in the fall, the Manhattan District gradually extended its control over administration of the program, culminating with Columbia's acceptance of a War Department contract on 1 May 1943. Shortly thereafter university and District representatives reorganized the diffusion research program, redesignating it as the SAM (for Special Alloyed Materials) Laboratories and appointing Urey as director. (*See Map 2.*) Maj. Benjamin K. Hough, Jr., who had come to Columbia in the spring as area engineer for the program, reorganized his office to conform to the SAM organization and moved with most of the rapidly expanding research activities from campus laboratories to more spacious facilities in the university's Nash Building, a few blocks north of the campus.[3]

Design and Engineering

The Military Policy Committee, after deciding to give priority to full-scale development of the gaseous diffusion process, selected the M. W. Kellogg Company to design and engineer the production plant, designated K–25 for security reasons. The choice was a logical one, for the firm was already extensively involved in diffusion research under OSRD contracts, including design of a ten-stage pilot plant for barrier development. On 14 December 1942, Kellogg accepted a letter contract from the Manhattan District, with some unusual provisions that reflected the unique character of the project. The Army required no guarantees from the firm that it could successfully design, build and put into operation a gaseous diffusion production plant. For reasons of security, the company agreed to set up a separate corporate entity, the Kellex Corporation, to function as a self-sustaining and autonomous organization for carrying out the project. Because of the great uncertainty regarding the precise scope and cost of the project, the District and Kellogg also agreed to defer fixing any financial terms until later execution of a formal fixed-fee contract. (This was not actually accomplished until April 1944, when Kellogg accepted payment of about $2.5 million for its work.)[4]

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[2] Smyth *Report*, pp. 125–26 and 132–33; Hewlett and Anderson, *New World*, pp. 97–101; MDH, Bk. 2, Vol. 2, "Research," pp. 4.11–4.12, 4.14–4.15, 7.2–7.3, DASA.

[3] Cert of Audit MDE 103-46, Columbia Area, 27 Feb 46, Fiscal and Audit Files, Cert of Audit Registers, MDR; MDH, Bk. 2, Vol. 2, pp. 2.1–2.2, 11.1–11.3, App. B (Org Chart, Columbia Area, 4 Aug 43), DASA; Groves, *Now It Can Be Told*, p. 111. Groves remembered the code name SAM as standing for Substitute Alloy Materials rather than Special Alloyed Materials.

Kellogg provided the Kellex Corporation with its own research, engineering, expediting, accounting, and service divisions. It designated one of its own vice presidents, Percival C. Keith, a Texas-born chemical engineer and graduate of Massachusetts Institute of Technology, to be executive in charge at Kellex. Keith, who had already gained considerable familiarity with the atomic bomb project through his service on the OSRD S-1 Section's planning board, not only drew upon managerial and technical employees of Kellogg but also borrowed personnel from other firms in order to staff Kellex. Kellex employees—some thirty-seven hundred at the height of the firm's activities in 1944—worked in the New York area at Kellex's headquarters in the downtown Manhattan Woolworth Building, at Columbia University's laboratory facilities in the Nash Building, and at Kellogg's Jersey City plant; and in Tennessee at the Clinton Engineer Works.[5]

To oversee the work of Kellex, as well as to handle the administrative details relating to the large number of Special Engineer Detachment personnel assigned to the firm (nearly one hundred by mid-1944), the district engineer in January 1943 established the New York Area Engineers Office in the conveniently located Woolworth Building and assigned Lt. Col. James C. Stowers not only as the new area engineer but also as the unit chief for the entire K-25 project. At the start Stowers supervised a military and civilian staff of less than twenty; it remained small, never numbering more than seventy. While monitoring performance on the Kellogg contract, this New York staff also coordinated the unusually complex developmental diffusion research of numerous contractors—including Princeton University working on barrier corrosion; Ohio State University on chemical compounds as feed materials and process gas; and Union Carbide's Carbide and Carbon Chemicals Corporation, Linde Air Products Company, and Bakelite Corporation, Western Electric's Bell Telephone Laboratories, and Interchemical Corporation, all on suitable barrier fabrication.[6]

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[4] Ltr Contract W-7405-eng-23, 14 Dec 42, and Formal Contract W-7405-eng-23, 11 Apr 43, both in Contract Files, OROO; MDH, Bk. 2, Vol. 2, pp. 3.4-3.6 and App. A, DASA; Memo, Nichols to Carroll L. Wilson (Ex Asst to Bush), sub: Background on P. C. Keith, 10 Jan 47, Admin Files, Gen Corresp, 201 (Keith), MDR; Ltr, Keith to WD, Attn: Groves, 25 Jan 44, Admin Files, Gen Corresp, 167, MDR.

[5] Memo, Nichols to Wilson, sub: Background on P. C. Keith, 10 Jan 47, MDR; Groves, *Now It Can Be Told*, pp. 112 and 428; Ltr, M. W. Kellogg to Groves, 9 May 45, Admin Files, Gen Corresp, 231.21 (Kellex), MDR; Ltr, Keith to WD, 25 Jan 44, MDR; MDH, Bk. 2, Vol 3, pp. 18.5-18.7 and Apps. C14-C15 (Org Charts), DASA.

[6] Ltr, R. B. Van Houten (Asst Proj Mgr, Kellex) to John H. Arnold (Kellex R & D Dir), sub: SED Personnel Assigned to Nash Bldg (with attached rosters), 28 Jun 44, Army Personnel Files, Box 73A (1-A), Kellex, OROO; Cert of Audit MDE 202-46, New York Area, 1 Nov 45, MDR; Memo, Groves to Dist Engr, sub: List of Personnel, 27 Sep 43, Admin Files, Gen Corresp, 201 (Gen), MDR; Org Chart, Kellex Corp., 8 Apr 45, Admin Files, Gen Corresp, 231.21 (Kellex), MDR; Org Charts, U.S. Engrs Office, MD, 15 Aug and 1 Nov 43, 10 Nov 44, 26 Jan 45, Admin Files, Gen Corresp, 020 (MED-

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Theoretical and Practical Problems

The complexities and difficulties in gaseous diffusion plant design arose from the nature of the process itself, which required a stable compound of uranium that would exist as a fluid at ordinary temperatures, and also from the almost total lack of any adequate data on what would happen when the process was transformed from a laboratory phenomenon into a mass production operation.[7] In 1941, Karl P. Cohen had worked out the fundamental theory of the gaseous diffusion process by applying the well-established Graham's Law to the only known gaseous compound of uranium, the highly corrosive uranium hexafluoride. Briefly stated, Graham's Law holds that if a mixture of two gases of unequal densities is placed in a porous container surrounded by an evacuated space, the lighter gas will tend to escape at a more rapid rate than the heavier. If the process can be controlled, separation can be carried forward by stages until an almost pure concentration of the lighter component is achieved. How much more of the lighter than the heavier component passes through a single stage depends upon the density of the gases and the difference in their molecular weights. In the case of uranium hexafluoride, the difference is very small indeed, the lighter U-235 constituting only 0.85 percent. Hence, the highest enrichment of the lighter isotope in a single stage is 1.0043 times that of the heavier.

In practice, the degree of single-stage separation actually attainable is affected by the size, number, and distribution of the apertures, or pores, in the barrier through which the process gas passes and the variations in the pressure of the gas itself. After investigating whether these limiting factors could be overcome sufficiently to make possible construction of an efficient plant in terms of time and output, Cohen proposed building a plant of forty-six hundred stages to produce 90 percent U-235. This plant would operate as a single cascade, with each stage feeding enriched material to the next higher stage and depleted material to the stage below. Operating at a relatively high pressure, the plant would have a low holdup of material in the barrier, thus reducing the equilibrium time—that is, the time required to complete the process.

(Org), MDR; MDH, Bk. 2, Vol. 2, pp. 2.2–2.5, Vol. 3, pp. 18.2–18.5 and Apps. C7–C13 (Org Charts), and Vol. 4, "Construction," App. C16 (Org Chart), DASA; Ltr, Keith to Nichols, 6 Aug 43, Admin Files, Gen Corresp, Misc File (unmarked fldr), MDR; Ltr, Tolman to Groves, sub: Visit to Bell Tel Labs To Discuss Work on Barrier Problem, 9 Oct 43, Admin Files, Gen Corresp, 319.1 (Rpts), MDR.

[7] Subsection based on MDH, Bk. 2, Vol. 2 (especially pp. 2.4 and 8.5–8.6) and Vol. 3, and Bk. 7, Vol. 1, "Feed Materials and Special Procurement," pp. 9.6–9.9, DASA; Hewlett and Anderson, *New World*, pp. 125–131; Gowing, *Britain and Atomic Energy*, pp. 57–58 and 218–25; Completion Rpt, M. W. Kellogg Co. and Kellex Corp., sub: K–25 Plant, Contract W–7405–eng–23, 31 Oct 45, pp. 5 (revised)–6, OROO; Interv, Author with Cohen, 8 Jul 82, CMH; Karl Cohen, *The Theory of Isotope Separation as Applied to the Large-scale Production of U–235*, ed. George M. Murphy, in Division III, *Special Separations Project*, National Nuclear Energy Series, Vol. 3 (New York: McGraw-Hill Book Co., 1951), pp. 5–29; Memo, Dunning to George T. Felbeck (K–25 Proj Mgr, Kellex), Albert L. Baker (Kellex Chief Engr), and Keith, sub: Importance of Low Humidity at K–25 Plant Site, 17 Apr 43, Admin Files, Gen Corresp, 601 (CEW), MDR; Safety Committee, Bull SM–2, Safety Committee Regulations for Handling C–126 (Fluorine), Admin Files, Gen Corresp, 729.31, MDR. On the question of cooler design, see Calendar of Events, Internal vs. External Coolers, 6 May 44, Admin Files, Gen Corresp, 001, MDR.

The single cascade design contrasted with the diffusion plant design on which British atomic scientists had been working since 1940. Their proposed plant would employ a cascade-of-cascades arrangement with low pressure and high holdup. Such a plant had certain advantages over the American design; its lower-operating pressure and temperature made the solution to the barrier problem easier and reduced the corrosive effect of the process gas. The British scientists also claimed their cascade-of-cascades plant would have greater operating stability and present fewer maintenance problems, but American engineers rejected the design because its high holdup would increase the equilibrium time substantially.

With the results of Cohen's studies and the British experiments at hand, SAM scientists and Kellex engineers worked as a team to design the basic gaseous diffusion production unit. This unit, designated the stage, had three main elements: a converter, control valve, and centrifugal pumps. The converter consisted of a barrier, its most central feature, and a cooler. The highly porous metallic barrier, initially comprised of flat plates but in final design made up of annular bundles of small tubes arranged and supported in much the same fashion as the conventional shell-and-tube heat exchanger long employed in steam-powered engines, filtered the process gas to separate uranium isotopes; the cooler, a circular bundle of finned copper tubes in the head of the converter, removed the process-generated heat and controlled the stage temperature. The system's control valve, an adaptation of the conventional butterfly valve, maintained the required stage pressure, and its centrifugal pumps, consisting of a booster and blower, transported and fed the process gas from one stage to another.

The Columbia-Kellex designers considered combining the stage's converter, control valve, and pumps in a completely sealed unit. This design offered certain advantages, especially with respect to maintaining a vacuum and preventing leaks. The unit, however, would be bulky and its components difficult to service. And, more importantly, its fabrication would require more time than separate fabrication of its component parts. To overcome these disadvantages, the designers modified their original diffusion stage concept. Final equipment designs called for the control valve and the pumps and its motors to be outside the converter. Although Carbide and Carbon engineers had suggested that the cooler be removed from the converter and manufactured as a separate unit, the Columbia-Kellex team rejected this proposal, feeling that such a change would slow down delivery of the converters.

This modified stage design, nevertheless, forced the Columbia-Kellex designers to contend with another mechanical problem—how to prevent leakage. After extensive testing they proposed that both pumps and motors be encased in a vacuum-tight enclosure containing inert gas, thereby eliminating the primary obstacle in centrifugal pump design: the need for seals. The Westinghouse Electric and Manufacturing Company built several models of this design, which Columbia scientists later successfully employed in laboratory tests. But before

Columbia could develop a production model, researchers at the Elliott Company in Pennsylvania had invented a radically different type of seal for centrifugal pumps. When tested at Columbia in early 1943, the designers determined that this new type of seal met all the requirements for the K-25 plant.

Some of the most difficult design problems arose from the necessity of using the highly corrosive uranium hexafluoride as the process gas. Because earlier efforts by the OSRD to find a substitute for uranium hexafluoride had failed, the Army expanded research by SAM, Princeton, and Du Pont scientists in an effort to devise ways to cope with the corrosive character of the gas. These investigations established that the adverse effects of corrosion could be inhibited through pre-installation conditioning of the process equipment and contributed to the design of treatment methods.

The Barrier Problem

The heart of the gaseous diffusion system was the barrier, the component that proved most difficult to design and fabricate.[8] Two objectives guided barrier research and development at Columbia University, as well as at Kellex: find a material that would efficiently separate U-235 and U-238 in a hexafluoride compound, and develop mass production methods for making the material into barriers. Ongoing tests soon revealed that this material had to have certain essential characteristics, namely, be highly porous; resistant to the reactive nature of uranium hexafluoride; capable of withstanding the stresses of fabrication, installation, and utilization; and suitable for mass production.

Columbia research had experimented with a great variety of metals and alloys over a two-year period (1941–42), testing many of them in Pilot Plant No. 1, but with repeated disappointment. Finally, in December 1942, the experiments of researchers Edward Norris and Edward Adler with a form of corrosion-resistant nickel revealed the material's highly promising characteristics for satisfying the exacting and rigorous barrier requirements. To manufacture the Norris-Adler barrier material in a continuous process, as well as to test other equipment under conditions approaching those anticipated in a large-scale diffusion plant, the research team at Columbia in January 1943 started building Pilot Plant No. 2, a six-stage cascade unit, in the

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[8] Subsection based on MDH, Bk. 2, Vol. 2, pp. 4.1–4.30 and 4.32–4.33, DASA; DSM Chronology, 16 Jun 44, Sec. 10, OROO; MPC Min, 13 Aug 43, MDR; Ltr, Tolman to Groves, sub: Visit to Bell Tel Labs To Discuss Work on Barrier Problem, 9 Oct 43, MDR; Ltr, Edward Mack, Jr. (SAM Labs), to Urey, 31 Mar 44, Admin Files, Gen Corresp, 319.1 (Kellex and Others), MDR; Ltrs, Urey to Groves, 10 May 43, and Urey to Hough, 10 Nov 43, Admin Files, Gen Corresp, 201 (Urey), MDR; Ltrs, Keith to Groves, 23 Oct 43, and W. A. Akers (British group) to Stowers, 26 Jun 44, and Min, Follow-up Review Conf (K-25), 5 Jan 44, Admin Files, Gen Corresp, 001, MDR; Memo, Stowers to Groves, 7 Jan 44, Admin Files, Gen Corresp, 095 (Kellex), MDR; Hewlett and Anderson, *New World*, p. 139; Memo, Tolman to Grove, sub: Status of Work on Pilot Plants, Barriers, etc., in N.Y., 13 Mar 44, Admin Files, Gen Corresp, 201 (Tolman), MDR; Memo, Nichols to Groves, sub: Requirement for Nickel Powder, 2 Mar 43, Admin Files, Gen Corresp, 600.12 (Research), MDR. In response to the atomic program's need for large quantities of powdered nickel, International Nickel Company built additional manufacturing facilities in West Virginia, New Jersey, and New York.

Nash Building. In early summer, this pilot plant began producing the Norris-Adler barrier material. Initial tests, however, revealed distressing structural weaknesses and production deficiencies; the nickel material's brittleness made fabrication into tubes difficult and the complex character of the manufacturing techniques created problems in achieving uniform quality of production.

Manhattan leaders, nevertheless, continued to be confident that the barrier problem would be solved satisfactorily. They intensified barrier research and testing efforts of the Columbia team, as well as those of the Kellex-Bell-Bakelite barrier research group experimenting with a powdered nickel barrier. The progress and results of these ongoing barrier-development experiments were reviewed and discussed in August, when the Military Policy Committee convened on the thirteenth. With cautious optimism, the committee concluded that a suitable—if not ideal—barrier would soon be designed and fabricated. an improved version of either the Norris-Adler or Kellex barrier. But ensuing results from months of testing dashed the Columbia scientists' hopeful expectations of producing good-quality barrier material; their Norris-Adler prototype, though much improved, was still too brittle and lacking in uniform quality. The Kellex-Bell-Bakelite team's experiments, however, particularly those with a material that combined some of the best features of the Norris-Adler and the powdered nickel barriers, demonstrated that its new barrier achieved good separation characteristics and presented fewer fabrication problems.

In early November, Groves endeavored to reach a workable solution as to the direction barrier development should proceed. After listening to arguments from Urey and the Columbia scientists in support of the latest barrier they had devised and to Keith and the Kellex group concerning the advantages of their improved powdered nickel barrier, Groves decided that the most feasible policy was to continue work on both types, the Kellex barrier providing insurance against the possible failure of the Columbia barrier. Predictably, this compromise was unpopular with both sides. Urey, in particular, who from the start had resented the diversion of effort from his own project to the Kellex group to accelerate barrier development, saw it as further indication of Groves's intention to exclude Columbia from all useful work on the atomic project, and he reminded the Manhattan commander that he had already transferred both the pile experiments and the heavy water research from Morningside Heights to Chicago.

Contributing to Urey's harsh judgment of the intent of Groves's action was his awareness of the discouragement felt by many of those working on the barrier problem. In fact, by the end of 1943, morale had plummeted to a very low point. Not the least of the factors causing this prevailing pessimism was adverse criticism of the Columbia-Kellex plant design by some members of the British delegation of scientists assigned to the atomic project. The British expressed decided preference for the cascade-of-cascades design of their own plant, arguing that the single cascade design of the American plant would not eliminate the "surges"—sudden, sharp variations in gas pressure—that might well make the Tennessee plant inoperable. While also stating a preference for Kellex's improved powdered nickel barrier over Columbia's, the British considered even the Kellex barrier to be far from perfected. Finally, too, the visiting scientists indicated great skepticism that Kellex would have the production plant in operation by the projected date, 1 July 1945. Groves sharply disagreed with the British on this last point, holding that, if Kellex was reasonably certain the plant would be operating by that date, it probably would be in production even sooner.

Keith and his Kellex colleagues particularly resented the visit of the British scientists. In January 1944, the Kellex chief asserted that the British had set progress back a month because of time spent answering questions and assisting them in making studies, many duplicating studies made by his own engineers months earlier. At the same time, he complained to the New York area engineer that Groves appeared to be avoiding a decision on the barrier question and also seemed to be trying to push back the plant completion date. Colonel Stowers wrote hurriedly to General Groves, expressing anxiety at the alarming decline of enthusiasm he noted in the normally ebullient and confident Kellex chief.

But much of the gloom prevailing at Kellex and Columbia was dispelled by developments in the early months of 1944. On 16 January, Groves met with representatives of Kellex, Carbide and Carbon, SAM Laboratories, and the Houdaille-Hershey Corporation to discuss progress on the barrier. The group convened at Decatur, Illinois, where Houdaille-Hershey was building a new plant for the manufacture of barriers of the Norris-Adler type. At the conclusion of the meeting Groves announced that the Decatur plant would be converted immediately so that it could produce Kellex's improved powdered nickel barrier, because it was considerably easier to fabricate and manufacture than the Norris-Adler. Fortunately, a lot of precious production time was not lost during the conversion process. Most of the equipment and many of the procedures for producing the Norris-Adler barrier were readily adapted for producing the Kellex type.

An important factor in Groves's decision to go ahead with mass production of the Kellex barrier was his knowledge of the International Nickel Company's successful production of a high-quality powdered nickel, thus providing a ready source of the type of nickel out of which the Kellex barrier could be best fabricated. In what proved to be a most fortuitous move, the Manhattan commander had directed Colonel Nichols in the spring of 1943 to have the company build facilities for the manufacture of barrier material. And because of this early start, company technicians by early 1944 had developed a process for producing powdered nickel of a type and quality especially suitable for fabricating the Kellex barrier. In fact, by April, the firm had accumulated in its storage facility some 80 tons, more than enough for immediate shipment to the diffusion pilot plants in New York.

Meanwhile, barrier developments at Columbia also provided more reason for optimism. Pilot Plant No. 2 had begun turning out sizable amounts of a good-quality Norris-Adler barrier. Thus, before receipt of the District's orders in April to convert No. 2 to manufacture Kellex's improved powdered nickel barrier, Columbia scientists had the satisfaction of being the first to achieve quantity production of their material.

Pilot plant testing and production of barrier materials continued apace into the summer of 1944. While providing the first opportunity to ascertain the separation qualities of the Kellex barrier under conditions simulating large-scale plant operations, these pilot plant tests demonstrated the need for more improvements. But, at this juncture, with the continuing lack of barrier components threatening to hold up further progress in design and construction of the main diffusion plant at the Clinton site, Manhattan Project leaders knew the time for experimentation was at an end. They now felt the urgency of directing all of their efforts to expediting Houdaille-Hershey's mass production of the less than ideal Kellex barrier in sufficient quantity to equip each of the thousands of stages of the Tennessee plant.

Plant Design

In the early stages of planning, everyone had assumed that the objective was to design and build a gaseous diffusion plant capable of producing a 90-percent-enriched product. But data that became available to the design teams from ongoing research and pilot plant studies indicated that considerable time in design and engineering would be saved if the cascade equipment were limited to that producing a product of lower enrichment. Theoretically, a cascade constructed with tubular barriers would be efficient up to the point of a 36.6-percent concentration; for higher product enrichment, quite differently designed barriers would be necessary. Furthermore, the plant designers soon discovered that, because of the greater capacities required, the centrifugal pumps under development for the lower stages could not be used above the 36.6-percent level. In other respects, too—for instance, increased likelihood of critical product accumulation—the design of the upper stages presented special problems.

General Groves, as early as February 1943, cited an alternative solution that would save much time and seemed certain to work: Why not take the output from the lower stages of the gaseous diffusion plant and feed them into the Beta phase of the electromagnetic plant? By mid-year, electromagnetic plant construction was going so well that this solution seemed all the more feasible. Groves therefore asked Kellex to submit estimated completion dates for 5-, 15-, 36.6-, and 90-percent plants. On the basis of these estimates, he then instructed Keith and the Kellex design teams to draw up plans for a 36.6-percent plant. Meanwhile, research on the upper stages continued on a reduced scale.

As a consequence, by late 1943, project design was making substantial progress in most directions. The knottier aspects of pump design and procurement appeared to be solved; soon, the Allis-Chalmers Manufacturing Company and several smaller firms would be able to satisy all of the District's requests for pumps in whatever quantities needed. Also, the pump seal problem appeared to be well on the way to solution.[9]

Although lack of a really suitable barrier had prevented development of adequate equipment for testing the diffusion operation on something approaching production plant scale, it had not held up completion of Kellex designs for the overall plant. These designs projected as the main gaseous diffusion production unit a cascade of 2,892 stages, connected in a single series. Ideally, Kellex engineers might have incorporated into the plant design a requirement for a converter and pumps of slightly smaller size at each successive stage in the cascade. Because this, however, would have resulted in extremely complicated and costly manufacturing and installation problems, they compromised. They provided for five different-sized pumps and four different-sized converters, thus dividing the whole cascade into nine variably pressurized sections. The sections normally would function as a single cascade, although each could be operated individually. Within each section the smallest operable unit was the cell, containing 6 stages enclosed in a sheet metal cubicle that would be supplied with dry air and kept heated to a uniform temperature.[10]

Design of the cascade unquestionably constituted the single most important and difficult feature of the gaseous diffusion production plant. But for the Kellex engineers it was only a small part of the job. Working in cooperation with numerous equipment and supply contractors, they also had to prepare blueprints and specifications for a vast array of support and control facilities. Cascade operation, for example, required purge cascades, process gas recovery, surge and waste, and product removal systems, as well as a large number of instruments for maintaining a constant check on all conditions throughout the plant. Plant instrumentation had to be extremely reliable, for even slight variations in such factors as pressure or temperature could produce adverse effects.

To house the main cascade and its auxiliary facilities, Kellex engineers designed a huge structure of fifty-four contiguous units, or buildings, arranged in a gigantic U-shaped pattern more than half a mile long on each side and a quarter of a mile wide. They laid out the interior of these buildings on four different levels: a basement housing lubricating and cooling equipment, ventilating fans and ducts, and transformers and electrical switchgear; a cell floor containing the steel-encased cells lined up in two parallel rows extending the length of a building; a pipe gallery carrying the main process lines and numerous auxiliary lines; and an operating floor, the location of most of the control devices and meters for cascade operation. At the operating floor level they placed a central control room at the base of the U, with instruments to keep track of the whole process and remote controls for all motorized valves.

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[9] Min, Coordination Committee Mtg, 13 Feb 43, and Ltrs, S. B. Smith (Kellex) to Stowers, 7 Sep 43, Admin Files, Gen Corresp, 337 (Univ of Calif) and (Kellex), respectively, MDR; Ltr, Oppenheimer to Nichols, 1 Jul 43, and Memo, Arnold and Dunning to Keith, sub: The Diffusion Plant, 28 Apr 43, Admin Files, Gen Corresp, 600.12 (Projs and Prgms: K-25), MDR; MDH, Bk. 2, Vol. 2, pp. 5.1-5.28, and Vol. 3, pp. 7.1-7.3 and 8.12-8.14, DASA.

[10] MDH, Bk. 2, Vol. 3, Secs. 8 and 9, DASA; Completion Rpt, Kellex Corp., sub: K-25 Plant, 31 Oct 45, pp. 5(revised)-8, OROO.

After completion of the cascade design for the plant at the Clinton Engineer Works (CEW), most of the research and development teams at Columbia and Kellex, and elsewhere, turned their primary energies to engineering and testing equipment and support facilities. With Groves's permission, however, a few SAM and Kellex researchers and engineers continued work on developing diffusion equipment that could achieve a higher product enrichment. In support of this investigation, in late summer of 1944 Kellex placed a 10-stage pilot plant in operation. By mid-January 1945, Kellex was ready to begin engineering and procurement for an extension to the upper stages of the K-25 plant that would bring the level of its product to an enrichment of approximately 85 percent. Groves authorized Kellex to proceed, but canceled the extension when data showed a greater product output could be achieved by increasing the amount of uranium of a lower percentage of enrichment for feeding into the electromagnetic plant. To achieve this goal, Groves directed Kellex to design and engineer a 540-stage side-feed unit (later designated K-27) in which the waste output from the main K-25 cascade could be combined with natural uranium to produce a slightly enriched product. By feeding the K-27 output into the higher stages of K-25, plant designers estimated the total production of U-235 could be increased by 35 to 60 percent. Kellex hoped to get the K-27 extension into operation early in 1946.[11]

Building the Gaseous Diffusion Plant

The Tennessee site for the gaseous diffusion plant consisted of a tract of 5,000 acres in the northwest corner of the CEW reservation, approximately 15 miles southwest of the town of Oak Ridge.[12] (*See Map 3.*) Enclosed on the north, south, and east by thickly wooded ridges and on the west by the Clinch River, the site had few roads, no railroads (although a main line was located a few miles to the north), and only one substantial structure (a country schoolhouse). Project engineers would have preferred a different location, especially one with lower average humidity; however, because the land at Clinton had been available for immediate purchase in early 1943, Manhattan leaders did not perceive the engineers' concern as critical as their own desire to get plant construction under way. Furthermore, they felt that the site satisfied other major requirements. It had a readily available water supply and a relatively level area of about 1,000 acres for the plant facilities, and its location was distant from the other production plants and the densely populated areas.

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[11] Dist Engr, Monthly Rpts on DSM Proj, Mar–Apr 45 to Mar 46, OCG Files, Gen Corresp, MP Files, Fldr 28, Tab A, MDR; MDH, Bk. 2, Vol. 3, Sec. 14, DASA; Completion Rpt, M. W. Kellogg Co. and Kellex Corp., sub: K-27 Extension, 31 Jan 46, p. 3 (revised), OROO.

[12] Subsection based on Completion Rpt, Kellex Corp., sub: K-25 Plant, 31 Oct 45, pp. 4, 8–10, 14–28, 30–31, 33 (revised), and maps following p. 40, OROO; MDH, Bk. 2, Vol. 4, pp. 2.6–2.7, 3.3–3.9, 3.46–3.51, 3.73–3.75, 5.1–5.4, 7.1, and Apps. C1 (Chart, Actual K-25 Constr Progress), C7 (Chart, Process Area Constr Progress), C16 (Org Chart), C25 (Chart, Daily K-25 Constr Forces), and Vol. 5, "Operation," pp. 6.3–6.4, DASA; Memo, Dunning to Felbeck, Baker, and Keith, sub: Importance of Low Humidity at K-25 Plant Site, 17 Apr 43, MDR; Groves, *Now It Can Be Told*, pp. 12 and 116–17; Completion Rpt, Kellex Corp., sub: K-27 Extension, 31 Jan 46, p. 21 (p. 2 of attached cost statement), OROO; Dist Engr, Monthly Rpts on DSM Proj, 1 Jul–9 Aug and Sep 43, Apr, Jun, Aug and Oct 44, and Mar and Sep 45, MDR; Org Charts, U.S. Engrs Office, MD, 15 Aug and 1 Nov 43, and 15 Feb 44, MDR; Maj William T. St. Clair (MD officer who monitored K-25 plant construction), Daily Diary, 9 Nov 43–13 Sep 45, passim, Kellex Records, Box 748, OROO; Draft Article, Maj Gen Leslie R. Groves, "Development of the Atomic Bomb," Admin Files, Gen Corresp, 000.74 (Mil Engr), MDR; Ltrs, Keith to Stowers, 6 Oct 44, Stowers to Dist Engr, sub: Change of Estimate Opn Date of Case I, 10 Oct 44, and Groves to Dist Engr, 1 Nov 44, Admin Files, Gen Corresp, 600.12 (Projs and Prgms: K-25), MDR; Ltr, Tolman to Groves, sub: Status of Case V, 1 Feb 45, Admin Files, Gen Corresp, 319.1 (Rpts), MDR.

Under terms of the prime contract with M. W. Kellogg, Kellex was to not only design and engineer the K-25 plant but also supervise its construction, using its own large field forces plus numerous contractors and subcontractors. The prime construction contractor was the J. A. Jones Construction Company of Charlotte, North Carolina, whose reputation on other Army projects had impressed Groves. Typical of the more than sixty subcontractors were the D. W. Winkleman Company for grading and drainage of the site, the Bethlehem Steel Corporation for steel work, and the Interstate Roofing Company for installation of heating and ventilating systems.

Wherever possible, Kellex delegated to Jones and the other contractors specific procurement of equipment and supplies needed in construction. Similarly, it contracted out thousands of orders for process and auxiliary equipment. Major equipment manufacturers were Allis-Chalmers for centrifugal pumps and motors of all kinds; the Chrysler Corporation for converters; and Houdaille-Hershey, Linde Air Products, and Bakelite for barrier material. Some of these firms—for example, Allis-Chalmers, Chrysler, and Houdaille-Hershey—had to build entirely new plants or undertake extensive conversion of existing facilities.

Through its rapidly expanding Manhattan District organization, the Army monitored and reviewed the many hundreds of agreements negotiated by Kellex, Jones, and other firms in late 1943. During the first few months of relatively limited operations at the building site, District Engineer Nichols exercised control over the project through the New York Area Engineers Office, whose staff maintained constant contact with the Kellex and Columbia University groups, and through the CEW Construction Division. But rapid expansion of construction and procurement activities eventually compelled Colonel Nichols to reorganize his Tennessee headquarters staff, establishing construction and operations divisions for each major production project. In his capacity as the K-25 unit chief, and in keeping with normal Corps of Engineers practice, Colonel Stowers organized the new K-25 Construction Division to parallel the organizational structure set up by the principal construction contractors—Unit I for the power plant, Unit II for the conditioning facilities, and Unit III for the

the process plant—and assigned Maj. William P. Cornelius as division chief.[13]

Actual construction started on the day after Memorial Day 1943, when a survey party began laying out the power plant site at an area adjacent to the east bank of the Clinch River. Two months later grading began in the area for the conditioning facilities—a large structure to house the treatment apparatus for coating process equipment with fluorine gas, thus providing protection against the extremely corrosive action of the uranium hexafluoride process gas, and a number of smaller buildings for the generation and storage of fluorine, production of gaseous nitrogen, and neutralization. To ensure these facilities would be ready in time so that K-25 workers could treat the process equipment before installation in the main production plant, Kellex and District authorities decided to engage a second major construction contractor—the firm of Ford, Bacon, and Davis—to build them.

Ground preparation on the main plant site did not start until 20 October 1943. Although relatively level by comparison with the surrounding terrain, the site was broken into ridges and valleys that required cuts up to 50 feet and fills averaging 25 feet. The great weight of the buildings that would house the cascade and its complicated, interconnected equipment made exceptionally stable foundations necessary. Ordinarily, such foundations would have been carried down to bedrock, a procedure that would have required thousands of concrete columns of different lengths. But, to save time, Kellex used the then novel method of compacted fill. Foundation workers put down earth in 6-inch layers, constantly checking in a field laboratory for proper moisture content and soil mixture. Then they compacted the fill with sheepsfoot rollers to a density slightly greater than that of undisturbed soil.[14] Next they poured the foundation footings directly on top of the undisturbed earth in the cut sections and on the compacted fill in the filled-in sections. In spite of the abnormally rainy weather in the fall of 1943, the K-25 workers' use of innovative construction techniques enabled them to complete laying down the foundations far more quickly than would have been possible with more traditional methods.

Kellex engineers also employed other time-saving methods, consistent with their basic goal of completing the production plant as rapidly as possible. Thus, wherever feasible, they overlapped activities normally carried out separately. The day grading began, J. A. Jones crews also poured concrete for the first building. And, as soon as the foundations had hardened, crews moved in heavy gooseneck cranes (the foundations had been deliberately designed to carry their weight) and began lifting the structural steel frames of buildings into place.

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[13] The conditioning area was comprised of facilities for preparing process equipment for installation in the process buildings. See Ch. XVIII for a fuller description of the design and construction of the K-25 power plant.

[14] Used to compact clay soil, a sheepsfoot roller is a towed roller with a large number of 4-inch-long steel bars welded radially to the surface of the roller drum. See *Dictionary of Civil Engineering*, s.v. "sheepsfoot roller."

Gaseous Diffusion Plant Under Construction at CEW

Another objective of Kellex's speedup techniques was to get some sections of the huge plant into operation as soon as possible. The firm's initial construction schedule, adopted in August 1943, provided for, first, completing one cell for testing; second, finishing one building as a so-called 54-stage pilot plant; and third, completing enough of the plant to produce an enriched product containing 0.9 percent U-235. The schedule designated this first production section, Case I. Three additional cases, with outputs of 5-, 15-, and 36-percent product enrichment,[15] would be finished as of 1 June, 15 July, and 23 August 1945, respectively. As construction progressed, Kellex engineers revised the original schedule to conform to changing conditions. Thus, the schedule of August 1944 called for completion in 1945 of Case I (0.9 percent) on 1 January, Case II (5 percent) on 10 June, Case III (15 percent) on 1 August, Case IV (23 percent) on 13 September, and a new Case V (36 percent) as soon as possible thereafter.

To ensure adherence to this highly complex and, in many respects unorthodox construction schedule, Kellex

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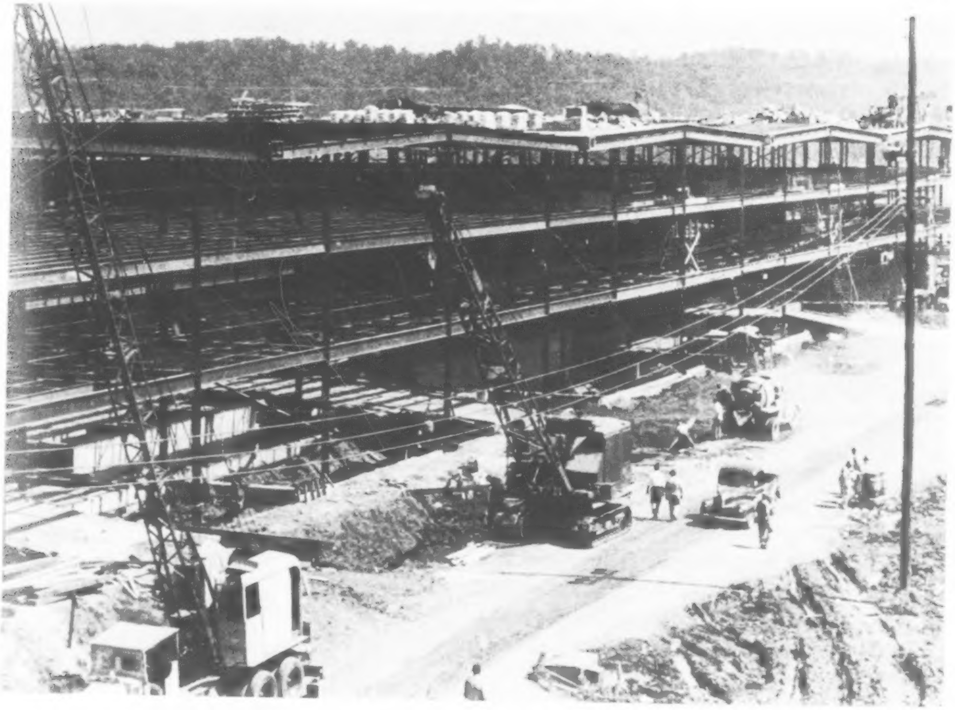
[15] In their projections of estimated output the Kellex design engineers reduced the original 36.6-percent level of product enrichment to 36 percent.

See Completion Rpt, Kellex Corp., sub: K-25 Plant, p. 3, OROO.



K–25 Steel-frame Construction

adopted a variety of rigid control measures. Typical were the two complete and identical charts the firm maintained, one in its New York office and the other at the construction site, on which it recorded the current manufacturing and delivery status of the hundreds of thousands of items required for building the plant.

There were times, however, when labor shortages, especially in the skilled categories, were acute. The contractors endeavored to overcome some of the shortages by on-the-job training and simplifying construction tasks wherever possible. Fortunately, too, because each stage of the plant was comprised of similar basic components, construction crews gained skill and speed from the repetitiveness of their work. With the Army's support, J. A. Jones and Ford, Bacon, and Davis also sought to improve living conditions and undertook other ameliorative steps for their workers, which reduced labor turnover and limited work stoppages to about 0.1 percent of total man-hours.[16]

One unusual feature of the construction work on the K–25 plant was the exceptionally stringent emphasis

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[16] See Chs. XVI and XVII for a more detailed discussion of manpower problems. See Ch. XXI for a description of efforts to improve living conditions for K–25 construction employees.

on cleanliness. Because even minute amounts of foreign matter would have highly deleterious effects on process operations, construction workers had to cleanse all pipes, valves, pumps, converters, and other items of equipment thoroughly before installation. Workmen in a special unit performed this vast operation in the large conditioning building, using equipment for solvent degreasing, alkaline cleaning, acid pickling, scratch brushing, surface passivation, and a variety of other procedures. When they finished, they sealed all openings to interior surfaces and kept them sealed until installation teams put the equipment into place.

To make certain no dust or other foreign matter polluted the system during installation, J. A. Jones instituted a rigid schedule of surgical cleanliness in installation areas. Isolating these areas with temporary partitions, the workers installed pressure ventilation, using filtered air. Then they cleaned the areas thoroughly, and inspectors carefully checked all personnel and material that entered them. Maintenance crews with mops and vacuum cleaners continued to remove any foreign substances that seeped in. When trucks had to enter, workers hosed them down at the entrances.

Workers wore special clothes and lintless gloves. Because certain work on equipment to be used in plant installations could not be done in the dirt-free areas, such as welding pipes and other small jobs, J. A. Jones installed special inflatable canvas balloons and the work was done inside them. The cleanliness control measures required many additional guards, inspectors, and supervisors, but they did not appreciably slow down the work. In fact, in some ways the good housekeeping actually facilitated the progress of construction.

Even more painstaking was the installation of more than 100 miles of pipe without flanged joints, and with welds that had to meet tightness specifications more severe than any ever encountered before in commercial construction. Pipe-fitting crews developed fourteen special welding techniques. Individual welders then learned the techniques, each specializing in those required for a particular type of installation. At the height of construction, there were some twelve hundred welding machines in use. All of the work required rigid control and tedious inspection to ensure joints were tight and no internal scale formed that might later find its way into the process system

At last, on 17 April 1944, the first 6-stage cell of the main plant was ready for test runs. Brief trial operations of this unit continued in May. During the summer months, as constuction crews finished additional stages, technicians put them through trial runs. Although barrier tubes were not available (installation of the first did not begin until fall of 1944), these tests permitted assembly of valuable data concerning performance of other plant components and detection of mechancial defects, such as leaks and sealant failures. Approximately two months behind schedule, equipment contractor workmen completed Case I (402 stages) to the point where processing of feed material could begin, but at least another month passed before the unit attained the 0.9-percent level. The other cases were completed either on time or ahead of schedule. Kellex and J. A. Jones transferred the last K-25 plant unit to Carbide and Carbon, the operating contractor, on 11 September 1945. Total construction cost, including the 540-stage side-feed extension (K-27) unit completed after the war, was $479,589,999.

Plant Operation

In late 1942, when the atomic project leaders were considering potential operators for the gaseous diffusion plant, Kellex's Percival Keith expressed a strong preference for the Union Carbide and Carbon Corporation.[17] In this leading chemical firm Keith saw a versatile organization with skilled personnel who would be able to not only operate the complex diffusion production process but also provide design, engineering, and construction assistance to hard-pressed Kellex engineers. Satisfied with Keith's opinion, Groves directed Manhattan representatives to commence negotiations with Union Carbide officials. Finally, in January 1943, Union Carbide agreed to become the prime operating contractor—but through its subsidiary, the Carbide and Carbon Chemicals Corporation—and selected one of its vice presidents, physical chemist and engineer George T. Felbeck, as project manager in charge of K-25 operations.

In the letter contract with Carbide and Carbon, Keith made certain that there was a provision for Kellex to obtain help in plant construction. Later modifications in the formal contract, signed in November 1943, extended the operating contractor's area of responsibility to include coordination of barrier research and development, construction and operation of a plant for producing nickel powder, conversion of Bakelite facilities to produce special barrier material, and assumption in February 1945 of the SAM Laboratories research program, hitherto operated by Columbia University.

Under terms of the prime contract, Carbide and Carbon was to receive an operator's fee of $75,000 per month for full plant operation, and additional payments as warranted. Although it would shoulder principal responsibility for production activities, it did not agree—as did Du Pont with the plutonium plant and the Tennessee Eastman Corporation with the electromagnetic plant—to serve as sole operator of the gaseous diffusion plant. Carbide officials did not want responsibility for conditioning the process equipment against the corrosive nature of the uranium hexafluoride process gas, nor did they want the potentially hazardous task of manufacturing the volatile fluorine gas used for conditioning.

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[17] Subsection based on DSM Chronology, 12 Dec 42, Sec. 4, OROO; Hewlett and Anderson, *New World*, pp. 120–22, 298–302, 374, 624–25; Dist Engr, Monthly Rpts on DSM Proj, Dec 44 and Jan–Sep 45, MDR; MDH, Bk. 2, Vol. 1, "General Features," pp. 4.6 and 5.7, Vol. 2, pp. 2.2–2.3, and Vol. 5, pp. 2.1–2.7, 3.1–3.6, 4.3–4.4, 8.1–8.16 (especially table following 8.3), 10.1–10.5, 12.1–12.2, and Apps. B1 (Chart, K-25 Vacuum Testing Opns and Progress), B22 (Org Chart, Ford, Bacon, and Davis, 31 Mar 44), F2 (Key Personnel, Carbide and Carbon), DASA; Smyth *Report*, p. 133; Org Charts, U.S. Engrs Office, MD, 15 Feb 44, 1 Jun 44, 28 Aug 44, 10 Nov 44, 26 Jan 45, MDR; Memo for File, Maj Wilbur E. Kelley (Y-12 Opns Div chief), 23 Sep 44, Admin Files, Gen Corresp, 600.12 (Projs and Prgms: K-25), MDR; Completion Rpt, Kellex Corp., sub: K-25 Plant, p. 3, OROO; Memo for File, Brig Gen Thomas F. Farrell (Groves's Dep), sub: Jul 12th Confs in New York, N.Y., 13 Jun 45, Admin Files, Gen Corresp, 337 (LC), MDR.

As an alternative, District officials had arranged with Chrysler, already under contract for manufacturing the converter component of the diffusion system, to do the conditioning. But when Kellex and Army authorities came to working out details of the equipment contract with the automobile firm, they learned that it lacked the necessary facilities for fluorine conditioning in its Detroit plant. Following months of delay, Manhattan and Carbide officials resolved the problem in November 1943. Based on recommendations by Union Carbide, Carbon and Carbide officials temporarily assigned responsibility for operating the conditioning facilities to the building contractor, Ford, Bacon, and Davis, and building and operating responsibility for the fluorine production facilities to the Hooker Electrochemical Company. Up until early 1945, when Carbide and Carbon assumed full operational control of these facilities, this arrangement permitted the prime operating contractor to concentrate its efforts on the process and power plants.

Preparations

During 1943, with gaseous diffusion plant production activities on a limited scale, the Manhattan District monitored the work of the several operating contractors through its K–25 Construction Division. When operations began to expand rapidly in early 1944, the district engineer established a K–25 Operations Division, headed by Maj. John J. Moran *(Chart 3)*. For months Moran's division functioned with only eight officers and five civil service employees. Then as the main diffusion plant became operational in 1945, the division acquired some additional personnel and, by the fall of that year, was operating with fourteen officers, nine enlisted men, and twenty civil service employees. But this was a relatively small staff to oversee the multifarious activities of a production plant that at the peak of its operations employed more than eleven thousand workers. It proved adequate, however, because Colonel Stowers, the K–25 unit chief, employed the staff of the New York Area Engineers Office, which he also continued to head, to assume a considerable part of the load of maintaining liaison among the major companies involved in gaseous diffusion operations.

In the spring of 1944, about the time construction crews were completing the first cell in the main process building, Carbide and Carbon began setting up its production organization at the plant site. The firm had been recruiting personnel for an operating force since late 1943, but with only limited success. And because recruitment difficulties also extended to supervisory and technical positions, the district engineer eventually had to augment the K–25 technical staff with skilled personnel from the District's Special Engineer Detachment.[18]

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[18] On specific problems in recruitment of supervisory and technical personnel see Memo, Stowers to Marshall, sub: K–25 Proj Requirements, 21 Jan 43, Admin Files, Gen Corresp, 600.12 (Projs and Prgms: K–25), MDR; MDH, Bk. 2, Vol. 5, pp. 2.1–2.4, DASA.

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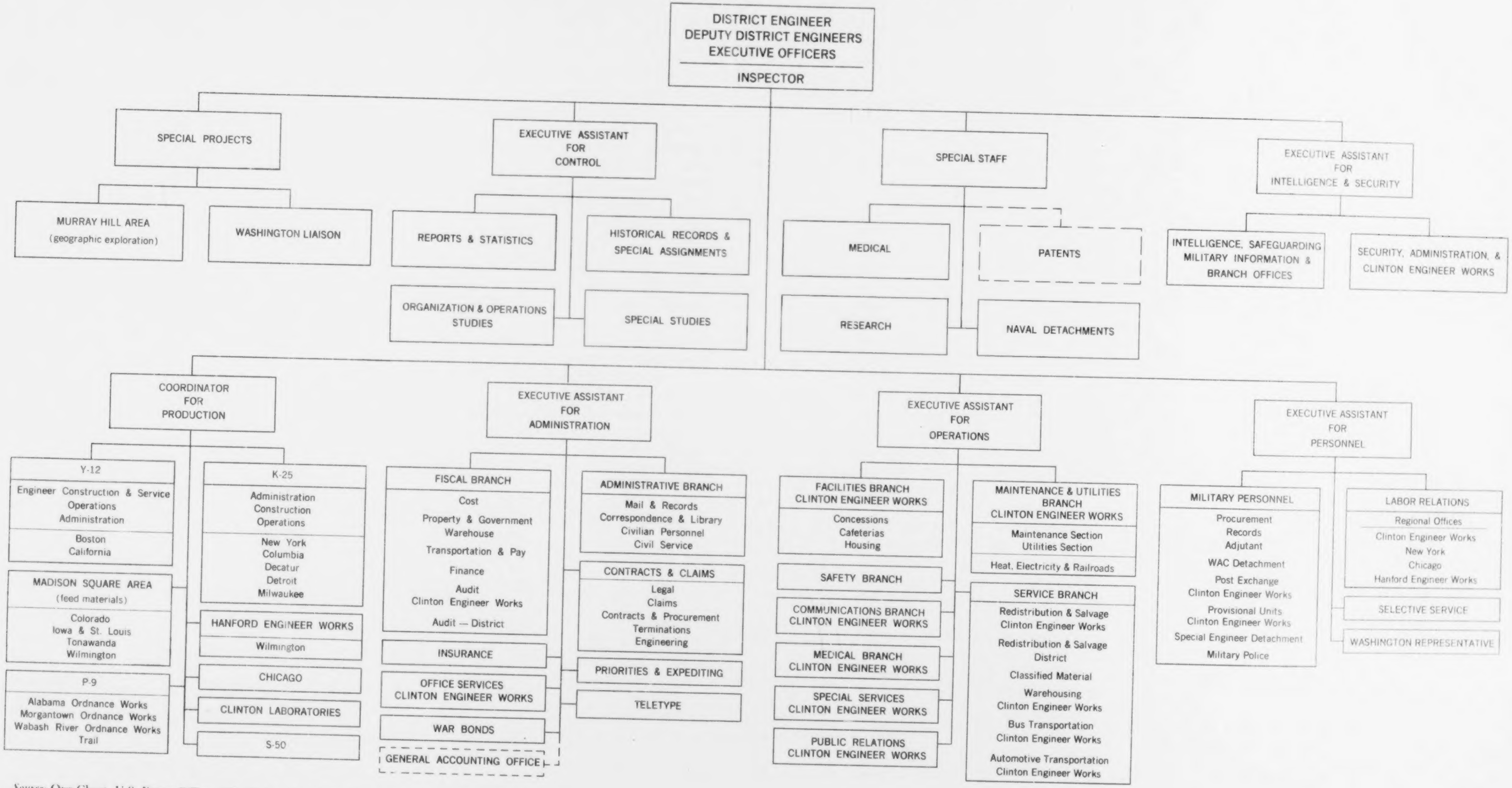
Chart 3—Organization of the Manhattan District, January 1945


DISTRICT ENGINEER
DEPUTY DISTRICT ENGINEERS
EXECUTIVE OFFICERS
INSPECTOR
SPECIAL PROJECTS
MURRAY HILL AREA
(geographic exploration)
WASHINGTON LIAISON
EXECUTIVE ASSISTANT FOR CONTROL
REPORTS & STATISTICS
HISTORICAL RECORDS & SPECIAL ASSIGNMENTS
ORGANIZATION & OPERATIONS STUDIES
SPECIAL STUDIES
SPECIAL STAFF
MEDICAL
PATENTS
RESEARCH
NAVAL DETACHMENTS
EXECUTIVE ASSISTANT FOR INTELLIGENCE & SECURITY
INTELLIGENCE, SAFEGUARDING MILITARY INFORMATION & BRANCH OFFICES
SECURITY, ADMINISTRATION, & CLINTON ENGINEER WORKS
COORDINATOR FOR PRODUCTION
Y-12
Engineer Construction & Service
Operations
Administration
Boston
California
K-25
Administration
Construction
Operations
New York
Columbia
Decatur
Detroit
Milwaukee
MADISON SQUARE AREA
(feed materials)
Colorado
Iowa & St. Louis
Tonawanda
Wilmington
HANFORD ENGINEER WORKS
Wilmington
CHICAGO
P-9
Alabama Ordnance Works
Morgantown Ordnance Works
Wabash River Ordnance Works
Trail
CLINTON LABORATORIES
S-50
EXECUTIVE ASSISTANT FOR ADMINISTRATION
FISCAL BRANCH
Cost
Property & Government Warehouse
Transportation & Pay
Finance
Audit
Clinton Engineer Works
Audit — District
INSURANCE
OFFICE SERVICES CLINTON ENGINEER WORKS
WAR BONDS
GENERAL ACCOUNTING OFFICE
ADMINISTRATIVE BRANCH
Mail & Records
Correspondence & Library
Civilian Personnel
Civil Service
CONTRACTS & CLAIMS
Legal
Claims
Contracts & Procurement
Terminations
Engineering
PRIORITIES & EXPEDITING
TELETYPE
EXECUTIVE ASSISTANT FOR OPERATIONS
FACILITIES BRANCH CLINTON ENGINEER WORKS
Concessions
Cafeterias
Housing
SAFETY BRANCH
COMMUNICATIONS BRANCH CLINTON ENGINEER WORKS
MEDICAL BRANCH CLINTON ENGINEER WORKS
SPECIAL SERVICES CLINTON ENGINEER WORKS
PUBLIC RELATIONS CLINTON ENGINEER WORKS
MAINTENANCE & UTILITIES BRANCH CLINTON ENGINEER WORKS
Maintenance Section
Utilities Section
Heat, Electricity & Railroads
SERVICE BRANCH
Redistribution & Salvage
Clinton Engineer Works
Redistribution & Salvage
District
Classified Material
Warehousing
Clinton Engineer Works
Bus Transportation
Clinton Engineer Works
Automotive Transportation
Clinton Engineer Works
EXECUTIVE ASSISTANT FOR PERSONNEL
MILITARY PERSONNEL
Procurement
Records
Adjutant
WAC Detachment
Post Exchange
Clinton Engineer Works
Provisional Units
Clinton Engineer Works
Special Engineer Detachment
Military Police
LABOR RELATIONS
Regional Offices
Clinton Engineer Works
New York
Chicago
Hanford Engineer Works
SELECTIVE SERVICE
WASHINGTON REPRESENTATIVE

Source: Org Chart, U.S. Engrs Office, MD, 26 Jan 45, Admin Files, Gen Corresp, 020 (MED-Org), MDR.

As newly recruited workers reported in, Carbide and Carbon made preparations for their orientation and training. By October 1944, a sufficient number of instructors and trainees were on hand to establish an operations training center in a building formerly occupied by the local public school. At the start, the center's curriculum consisted of two major courses: process training and vacuum test training. Later, courses were added for process maintenance men and instrument mechanics. In the beginning, only men were enrolled, but the continuing shortage of workers compelled Carbide and Carbon to recruit a large number of women as process operators. After employees had received more than eighty hours of formal classroom training, they underwent a period of on-the-job training before final assignment to an operating position.

In August 1944, some new workers had the opportunity to acquire practical experience on the operation of the 54-stage pilot plant, an experimental unit located at the base of the U in the main process building. The barrier tubes were not yet available, so the cell stages were fitted with steel orifices instead of converters. This meant, of course, that no isotope separation could occur. But, using either nitrogen or "test fluid," [19] the operator trainees simulated actual plant operations and plant managers were able to develop operating techniques, provide realistic training for foremen and key operators, and test performance of seals, pumps, and valves. In January 1945, Carbide moved all training activities from outlying buildings to the 54-stage pilot plant.

Production Activities

By the end of 1944, J. A. Jones construction crews were ready to turn over the first 60 of the 402 stages of Case I—the first major section of the production plant. Jones employees tested pumps, instruments, and other equipment for operability in the presence of Carbide and Carbon representatives, noting in an acceptance report all deficiencies that would require adjustment, repair, or replacement. Witnesses from both firms then had to approve the report before a completed plant section could be turned over to the operating staff for another series of tests preliminary to actual production.

A typical preoperation test was to make certain no leaks existed in the process system, because the separation process would operate effectively only under conditions approaching an absolute vacuum, with an infinitesimally small pressure buildup. SAM Laboratories vacuum technicians and Carbide and Carbon employees, all specially instructed in detecting leaks, worked together to carry out the delicate preoperation test. The test teams pumped down the process equipment

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[19] "Test fluid," the chemical compound n-perfluoroheptane (C_7F_{16}) project chemists had developed for process building test runs, was a nonhydrogenous gaseous material with characteristics similar to the process gas, uranium hexafluoride, except that it was noncorrosive. During test operations in the first three buildings, however, C_7F_{16} exhibited a number of technical deficiencies. Consequently, in February 1945, project chemists decided to discard it in favor of using the process gas in final test runs, realizing that the latter—although highly corrosive—would provide the same test information with a considerable savings in both time and labor. See MDH, Bk. 2, Vol. 5, pp. 3.4–3.5, DASA.

Completed Plant Section *with corrugated steel sheathing*

to a high vacuum and then played a stream of helium water over every welded joint, instrument, and valve. If there were leaks, helium would enter the system, where a mass spectrometer would detect it. Some four hundred to six hundred test personnel ultimately had to devote about eight months to complete a check of the whole gaseous diffusion plant.

As soon as a unit, or building, successfully passed the leak-test requirements, plant operators prepared it for a test run with regular process gas. Before they could do this, however, they had to make a thorough check and calibration of all instruments and carry out final conditioning of equipment. The 130,000 instruments in the main process area—probably up to that time the largest number ever installed in a single production plant—included many that were of special design and development and some that (for example, the mass spectrometers) were extremely delicate and complicated. Many, too, never before had been used routinely in a commercial-scale plant. Consequently, months of painstaking testing, calibrating, and checking were necessary before the final steps to put the plant into operation.

Units in the production plant cascade began operating for the first time on regular process gas in February 1945, testing procedures that subsequently were employed throughout the plant. The initial step was vaporization of the feed material—solid uranium hexafluoride from the Harshaw Chemical Company in Cleveland—by subjecting it to a series of hot baths to convert it into a gas. The feed material then entered the process stream in its gaseous form at any convenient feed intake point and flowed through the cascade of enriching stages. Emerging from these stages, the process gas went through a stripping section that carried depleted gas from the higher enrichment stages back to the lower part of the cascade for recirculation.

By early March, construction crews had completed sufficient additional cells to permit start-up of a two-building cascade. Unfortunately, on the ninth, as the actual start-up procedure began, nitrogen flooded the two-building cascade, because a worker had failed to close a valve in a bypass line. But quick purging action by plant crews soon cleared the system and, by the twelfth, they not only had the two-building cascade in partial production but also had connected two more buildings to the system. On the twenty-fourth, the whole of Case I went on stream. In the months following, Cases II through IV were finished at the rate of a case per month, until in mid-August the full plant cascade of 2,892 stages was in operation.

From the start, production results were much better than anticipated, despite occasional minor interruptions because of equipment failures and operational errors.[20] By May 1945, Cases I and II were turning out a product containing 1 percent U–235. In the following month, using slightly enriched material from the liquid thermal diffusion plant as feed, operators drew off some product containing nearly 7 percent U–235. After the full plant cascade went on stream, product concentration increased to 23 percent. During the fall, the plant demonstrated a productive capacity far higher than its designers had predicted. Contributing to this increased rate of output was a cell stream efficiency and barrier performance greater than expected.

In early 1945, the District's Production Control Committee, appointed earlier by Colonel Nichols to coordinate production by the diffusion processes and the electromagnetic process, had worked out a plan to achieve the maximum feasible output of U–235. Based upon a careful analysis of each process, the committee directed that K–25 would not be brought into the production chain until it demonstrated a capability of producing a product enrichment of 1.1 percent. The K–25 plant attained the 1.1-percent level in April, and project workers began sending the output to the electromagnetic plant for final enrichment. At the same time, thermal diffusion plant workers who had been sending the plant's output to the relatively inefficient Alpha I stage of the electromagnetic plant now began delivering the entire product output to K–25. Thus, the gaseous diffusion process became an integral part of the U–235 production chain and, during the spring and summer of 1945, contributed substantially to the manufacture of the fissionable material used in the fabrication of atomic weapons at the Los Alamos Laboratory.

The Army's success in bringing the vast and complex gaseous diffusion

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[20] For a detailed listing of these interruptions luring the period of getting the K–25 plant into full peration in the spring and summer of 1945 see bid., pp. 8.4–8.7, DASA.

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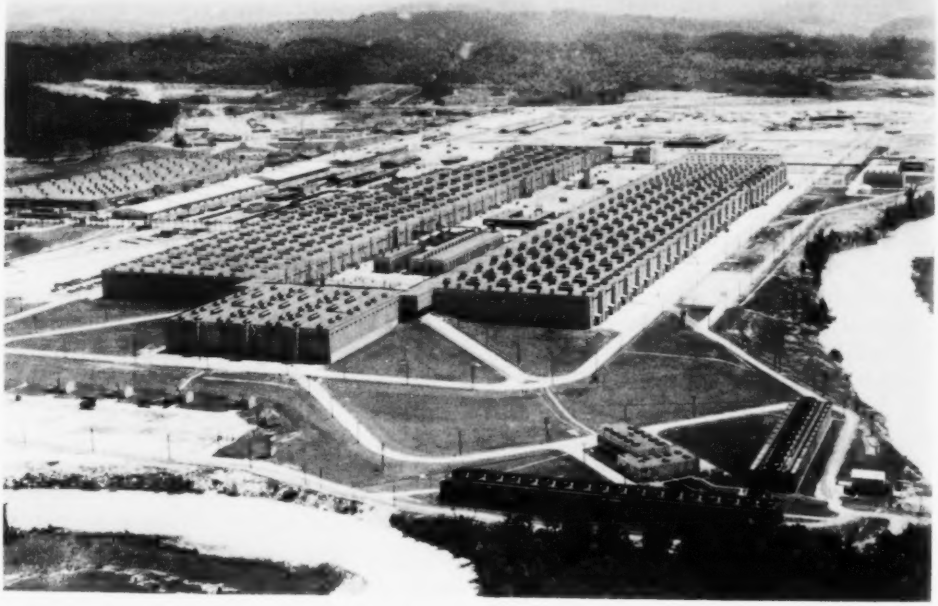

COMPLETED GASEOUS DIFFUSION PLANT. *The K–27 extension unit subsequently was erected adjacent to Poplar Creek, at the upper right.*

plant into full-scale production was to a considerable extent due to its having formed in the union of Kellex and Carbide and Carbon an effective organization with the requisite resources, industrial knowledge, and skilled personnel. Fortunately, during most of the 1943–45 period when first the K–25 plant and then its K–27 extension were being brought from the draftsman's table to fully operating production units, the various Kellex-Carbide elements functioned together surprisingly smoothly and efficiently considering the unrelenting pressure of time and the frustrations created by all kinds of wartime shortages in material and manpower.

Inevitably, however, there were occasional misunderstandings and personality conflicts that threatened to disrupt the teamwork of the organization. One such incident occurred in June 1945, when Kellex was phasing out participation in the project and leaving primary responsibility for plant operation to Carbide and Carbon. At this time, a dispute arose over the role of Kellex's strong-minded executive in charge, Percival Keith. The problem seemed to be that Carbide officials thought Keith was no longer devoting as much time to gaseous diffusion as he should, whereas Keith felt that he should be the judge of how much of his time should be spent on the project. After exceptional effort on the part of General Groves and his staff, Keith yielded to persuasion and agreed to stay on in an advisory capacity to assist Carbide and Carbon in operating the production plant.

Considered in terms of its ultimate production capabilities, the gaseous diffusion plant did not attain a significant level of output until the fall of 1945, after World War II had ended. This was not the result of poor planning or a failure to fulfill, in the main, established construction and production schedules. Rather it stemmed from the fact that when Groves and the other leaders of the atomic energy program were working out the plans for the plant in 1943, the consensus of opinion was that the war against Japan would last at least until mid-1946. Had this been the case, the K-25 plant would have attained the level of maximum output at the time when U-235 would be needed in large quantities for the weapons fabrication program. Events, of course, did not unfold quite as the atomic project planners had anticipated, and the war ended in August 1945. Consequently, full-scale operation of K-25 and its K-27 extension constitutes an episode in the immediate postwar history of the Manhattan Project rather than its wartime aspect. In this postwar period, the great industrial complex so hurriedly designed, erected, and placed in operation, employing largely inexperienced personnel working under far from favorable conditions, demonstrated that it was the most efficient and productive of all the process plants built to manufacture U-235.

Shortly after the war was over, the Manhattan District shut down the liquid thermal diffusion plant and the Alpha units of the electromagnetic plant. But the gaseous diffusion plant continued in operation as the basic source of U-235 for the entire atomic project. And in the postwar era, the great plant at the bend of the Clinch River became the prototype for new facilities built elsewhere in the United States to increase output of U-235, and also for the production units built in other countries to manufacture fissionable uranium for atomic energy programs.[21]

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[21] See Ch. XXVIII on the closing down of the liquid thermal diffusion plant and the Alpha units of the electromagnetic plant.

CHAPTER VIII

The Liquid Thermal Diffusion Process

Leaders of the atomic energy program had decided against large-scale development of the liquid thermal diffusion process in early 1943, partly because they judged the process infeasible and partly because transfer of a Navy project to the Army-directed Manhattan Project was likely to result in major administrative and security problems. By the spring of 1944, however, significant progress in thermal diffusion research—coupled with the threat of not reaching the requisite production level of fissionable uranium because of delays in getting the electromagnetic and gaseous diffusion plants into full operation—opened the way for serious reconsideration of this method as a means for providing a supplementary supply of partially enriched material for the Los Alamos Laboratory weapon program.

Research and Development: The Role of the Navy

One advantage of the liquid thermal diffusion method of separating isotopes was its relative simplicity. When a liquid containing isotopes of a given element is placed in the annular space between two vertical concentric receptacles, the inner one heated and the outer one cooled, thermal diffusion—that is, the passage of heat from the hot to the cold wall—tends to concentrate lighter isotopes near the hot wall and heavier isotopes near the cold wall and, simultaneously, because of convection, to carry the hotter liquid upward and the cooler fluid downward. The result is accumulation of lighter isotopes at the top of the receptacle and heavier isotopes at the bottom, thus permitting extraction of both fractions.

This method, first tested in the late 1930's by German scientists using zinc salts dissolved in water, had produced a small amount of separation; however, the phenomenon remained a little-known scientific curiosity until, in 1940, wartime events precipitated intensive research by American scientists to secure the fissionable materials necessary for the atomic project. In Washington, D.C., chemist Philip H. Abelson of the Carnegie Institution and physicist–technical adviser Ross Gunn of the Naval Research Laboratory simultaneously sought financial support from the government for a liquid thermal diffusion research program. Abelson, who had worked with chemist Glenn Seaborg on plutonium chemistry at the University of California, Berkeley, wrote to Uranium Committee Chairman Lyman Briggs at the National Bureau of Standards and described how uranium isotopes might be separated by thermal diffusion, and Gunn, also a member of the Uranium Committee, passed on to other committee members his own interest in the potentialities of the process. Acting on Briggs's suggestion, the Navy decided to support research in hopes that it might provide fuel for a nuclear power plant suitable for submarines.

Abelson started his research at the Carnegie Institution, but in October 1940 moved his experiments to the Bureau of Standards. Then in June 1941, at Gunn's suggestion, Abelson became an employee at the Naval Research Laboratory, which had been providing funds for his experiments since September 1940, and shifted his equipment to that institution. Using 36-foot columns consisting of two vertical concentric pipes, the inner carrying hot steam and the outer process liquid, Abelson began actual tests with uranium hexafluoride, a compound so little known at the time that he had to devise his own method for producing the substance in quantity. Results were disappointing at first; however, by changing the spacing between the hot and cold walls of the columns, Abelson was able to demonstrate that a separation factor as high as 21 percent could be achieved and an equilibrium separation could be attained in about two days.[1]

In August 1942, when Abelson's research had progressed to the stage where he needed a pilot plant to ascertain the feasibility of operating a large-scale plant, the Navy undertook the task of building the first thermal diffusion pilot plant at its Anacostia Station near the Naval Research Laboratory facilities. Completed by November, the original pilot plant consisted of five (later others were added) 36-foot columns and the requisite pumps, piping, and other equipment; a recently installed 20-horsepower gas-fired boiler provided the necessary steam. From the start of operations in December, the plant proved amazingly reliable, running for days at a time with scarcely any attention from the operating staff. Then in early 1943, the staff discovered that greater operational efficiency resulted from increasing the temperature of the hot wall. Although the higher temperature complicated design because of the high pressures required for hotter steam, it largely overcame the excessively long equilibrium time required for the plant to reach the stage of producing significant amounts of U-235.

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[1] On the early history of the liquid thermal diffusion method see Progress Rpt, Philip H. Abelson, sub: Liq Therm Diff Research (Rpt 0-1977), 5 Jan 43, Admin Files, Gen Corresp, 600.12 (Therm Diff Proj), MDR; MDH, Bk. 6, Sec. 2, "Research and Development," pp. 2.1-2.4, DASA; Hewlett and Anderson, *New World*, pp. 32 and 168-70; Smyth *Report*, p. 47.

Reassessment: Decision for Full-scale Development

For a time in late 1942, the liquid thermal diffusion method appeared to have been eliminated from further serious consideration for the atomic weapon program. In September, General Groves and Colonel Nichols had visited the Naval Research Laboratory and had talked to Gunn, but the small size of the project and the apparent lack of urgency of its developmental program had left the Manhattan commander unimpressed. Groves, too, recalled that Vannevar Bush, director of the Office of Scientific Research and Development, had just told him that in March President Roosevelt had directed that the Navy be excluded from the S–1 program. Yet in late November, the S–1 Executive Committee reassessed all of the more promising methods for mass production of fissionable materials and, at the last moment, decided to include Abelson's project in its review.[2]

General Groves and the S–1's reassessment group, the Lewis reviewing committee headed by MIT Professor Warren K. Lewis, visited the Naval Research Laboratory on 10 December and were sufficiently impressed with Abelson's progress to recommend continued support of the thermal diffusion project. Bush took steps to get continued support from the Navy, channeling his efforts through Rear Adm. William R. Purnell of the Military Policy Committee to avoid conflict with the President's directive to keep the Navy out of the S–1 project. Purnell had Abelson's latest scientific reports sent to S–1 Committee Chairman James B. Conant, who turned them over to the S–1 Executive Committee. An S–1 subcommittee, comprised of Lyman Briggs, Eger V. Murphree, and Harold C. Urey, reviewed the reports and visited the Navy project. On 23 January 1943, they informed Conant that "the Naval Research Laboratory . . . [had] made excellent progress in the separation of isotopes by liquid thermal diffusion . . . ,"[3] but expressed concern over the lack of solid production data and the excessive length of the equilibrium time. Consequently, the subcommittee limited its recommendation to suggesting that a commercial organization be invited to prepare preliminary designs for a production plant, a stage of development that the gaseous diffusion and centrifuge projects had attained nearly a year earlier. But two days later Murphree reviewed his own estimate of Abelson's project and proposed that the Manhattan leaders consider substituting liquid thermal diffusion for gaseous diffusion in the lower stages of a U–235 separation plant.[4]

At the beginning of February, General Groves submitted the various proposals concerning thermal diffusion and the reports from Abelson to the Lewis reviewing committee. After due consideration the committee suggested continuing with a limited program of research and preliminary engineering designs. The S-1 Executive Committee accepted this recommendation on the tenth, and another review by Lewis, Briggs, Murphree, and Urey toward the end of the summer resulted in essentially the same recommendation.[5]

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[2] Ltr, Briggs, Murphree, and Urey to Conant, 23 Jan 43, Admin Files, Gen Corresp, 600.12 (Therm Diff Proj), MDR; Marshall Diary, 21 Sep 42, OCG Files, Gen Corresp, Groves Files, Misc Recs Sec, behind Fldr 5, MDR; Groves, *Now It Can Be Told*, p. 23; Hewlett and Anderson, *New World*, pp. 169–70.

[3] Ltr, Briggs, Murphree, and Urey to Conant, 23 Jan 43, MDR.

[4] Memo, Nichols to Groves, 20 Jan 43, Admin Files, Gen Corresp, 319.1 (Liq Therm Diff), MDR; Hewlett and Anderson, *New World*, p. 171 (based on Ltr, Murphree to Briggs, 25 Jan 43, OSRD).

From September 1942 until April 1943, there was an almost complete loss of contact between the Navy program and the Manhattan Project. This temporary exclusion from the main arena of atomic energy activities did not, in the long run, seriously impede continued development, although Groves's refusal in October to approve Abelson's request for additional supplies of uranium hexafluoride momentarily threatened the program. Groves soon relented, however, when Navy officials reminded him that Abelson was the scientist who had devised the process for producing large quantities of uranium hexafluoride. Abelson needed the increased quantities of the compound for the three-hundred-column high-pressure pilot plant he planned to build at the Philadelphia Navy Yard, where there was an adequate supply of steam available. The Navy finally authorized construction of the new plant in November and work started on a one-hundred-column segment in January 1944.[6]

The final impetus for full-fledged development did not come from the Army or the S-1 Committee, but from that element most vitally concerned with obtaining an early and adequate supply of fissionable materials: the Los Alamos Laboratory. In particular, Laboratory Director J. Robert Oppenheimer was constantly on the alert for any means that gave promise of speeding up large-scale production of fissionable materials. At a time when the electromagnetic plant at the Clinton Engineer Works was just beginning to produce a sizable amount of enriched uranium and completion of the gaseous diffusion and plutonium production plants still was many months away, Oppenheimer reviewed certain fragmentary data received earlier on the thermal diffusion project. His information included two nearly year-old reports by Abelson and some oral reports received from Capt. William S. Parsons, the naval officer in charge of ordnance at Los Alamos.

Parsons had just returned from a trip to the East, during which he had made inquiries about the pilot plant under construction at Philadelphia. He had learned that the plant was scheduled to begin operating on 1 July, using one hundred columns to produce an estimated 5 grams per day of an enriched product containing 5 percent U-235. Oppenheimer knew that partially enriched material in such small quantities would not begin to fulfill the requirements of the atomic

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[5] Ltr, C. H. Greenewalt (TNX Tech Div chief, Du Pont) to Groves, 8 Feb 43, Admin Files, Gen Corresp, 600.12 (Therm Diff Proj), MDR; Hewlett and Anderson, *New World*, pp. 171-72; Rpt, Murphree and Urey, sub: Prgm for Experiments To Be Carried Out on Therm Diff Method, 19 Feb 43, Admin Files, Gen Corresp, 319.1 (Liq Therm Diff), MDR; Ltrs, Briggs, Urey, Murphree, and Lewis to Conant, 8 Sep 43, and Conant to Purnell, 15 Sep 43, Admin Files, Gen Corresp, 334 (Mil Policy), MDR.

[6] Hewlett and Anderson, *New World*, pp. 171-72; MDH, Bk. 6, Sec. 2, pp. 2.4 and 2.9, DASA; Smyth *Report*, p. 147

project; however, the thought occurred to him that if the one hundred columns of the plant could be connected in parallel rather than as a fractionating pyramid, they might be made to produce something like 12 kilograms a day of an enriched product containing about 1 percent U-235. And this output would be tripled if Abelson carried out his plan to erect a total of three hundred columns, the number that could be operated on the steam available at the Philadelphia Yard. On 28 April, Oppenheimer wrote to Groves that development of the thermal diffusion process to provide partially enriched uranium feed for the electromagnetic process would give "hope that the production of the Y-12 [electromagnetic] plant could be increased by some 30 or 40 percent, and its enhancement somewhat improved, many months earlier than the scheduled date for K-25 [gaseous diffusion] production." [7]

Groves did not reply immediately. In later years he stated he did not know why he or someone else had not suggested thermal diffusion as a feeder process for the electromagnetic plant at least a year before; perhaps, he conjectured, this occurred because everyone at first had thought of using a single process to achieve a final product enrichment and, as a single production system, thermal diffusion had certain technical drawbacks. But by August 1943, Manhattan leaders had adopted the feeder concept for the gaseous diffusion plant, proposing to use its output to feed the Beta cycle, and in this new context they were then able to perceive the potentialities of thermal diffusion.[8]

Unquestionably, too, development by an organization outside the Army-administered Manhattan District was an important factor contributing to the delay. For this reason it did not attract the active interest of most of the scientists and engineers who organized the bomb project, and the Army administrators feared security problems from bringing outside agencies into the Manhattan Project. That the latter consideration created at least some reservation in Groves's mind as to the feasibility of Oppenheimer's suggestion seems borne out by the fact that the Manhattan commander, who was not characteristically a man to allow grass to grow under his feet, let a whole month pass before acting upon it. Finally, on 31 May 1944, Groves appointed a committee consisting of Lewis and Murphree, who had previously investigated the Navy project, and physicist Richard C. Tolman, who was serving as his scientific adviser. This committee confirmed Oppenheimer's information, except they found his prediction regarding the potential output of the one-hundred-column plant overly optimistic. Groves informed Oppenheimer that he did not know yet whether the Manhattan District would avail itself of the Navy's facilities but that "arrangements have been made for this eventuality if it should be desirable." [9]

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[7] Ltr, Oppenheimer to Groves, 28 Apr 44, Admin Files, Gen Corresp, 600.12 (Therm Diff Proj), MDR; *Oppenheimer Hearing*, pp. 164-65.

[8] *Oppenheimer Hearing*, pp. 119-20.

[9] Ltr, Groves to Oppenheimer, 3 Jun 44. See also Memos, Groves to Lewis, Murphree, and Tolman,

Continued

RICHARD C. TOLMAN (*1945 photograph*)

On 5 June, Groves sent Conant and Lewis to District headquarters to confer with Colonel Nichols concerning the practical feasibility of using the Navy pilot plant at Philadelphia and constructing a thermal diffusion plant at the Tennessee site, employing steam available from the K-25 powerhouse. The two scientific leaders ultimately concluded the thermal diffusion plant "would probably be a feasible [and] desirable adjunct to the Y-12 process." [10]

Then on the twelfth, Groves requested that Murphree, who had extensive industrial experience, make a study to determine the cost, construction time, and amount of high-pressure steam needed for a thermal diffusion plant capable of producing 50 kilograms a day of enriched uranium with concentrations of U-235 ranging from 0.9 to 3.0 percent. Murphree asked Tolman and the scientists Karl P. Cohen and W. I. Thompson, both of whom had participated in previous investigations of the Navy project, to assist him in making the study. They concluded that the 1.25-million pounds per hour of steam that the K-25 powerhouse (with some modifications) could supply would be approximately sufficient to operate a thermal diffusion plant of sixteen hundred tubes, costing about $3.5 million, and capable of enriching 50 kilograms of uranium a week to slightly less than 0.9-percent concentration. [11]

Groves decided on 24 June to go ahead with construction. Such a plant promised to be relatively cheap. It could use the already available steam capacity at the gaseous diffusion plant site at least for several months, pending completion of the K-25 cascade. While its product would contain only about 20 percent more U-235 than natural uranium, this enrichment would be translated into a vital 20-percent-greater output by the electromagnetic plant. But Groves decided against the recommendation to include the existing Navy facilities, be-

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sub: Possible Utilization of Navy Pilot Therm Diff Plant, 31 May 44, and Lewis, Murphree, and Tolman to Groves, same sub, 3 Jun 44. All in Admin Files, Gen Corresp, 600.12 (Therm Diff Proj), MDR.

[10] Memo, Nichols to Groves, 11 Oct 44, Admin Files, Gen Corresp, 600.12 (Projs and Prgms), MDR. See Ch. XVIII for a detailed description of the K-25 powerhouse.

[11] Ltr, Murphree to Groves, 22 Jun 44. See also Rpt, Thompson and Cohen, sub: Process Design for Liq Diff Plant, 17 Jun 44; Rpt, Thompson and Cohen, Sub: Rough Prelim Estimate of Plant Cost, 19 Jun 44; Ltrs, Tolman to Groves, subs: Further Info as to Steam Capacity at Tenn., 19 Jun 44, and Still Later Info as to Steam Capacity at Tenn., 20 Jun 44. All in Admin Files, Gen Corresp, 319.1 (Liq Therm Diff), MDR.

cause the Navy installation would not be under direct control of the Army and because he was convinced that the Manhattan District would build the thermal diffusion plant more quickly if it were not diverted by the problems of operating the Navy plant. Both Groves and Nichols held to the view that the key factor was getting the plant into operation at the earliest possible date to fill the anticipated gap between the time the electromagnetic plant reached full capacity and the gaseous diffusion plant began producing large quantities of enriched uranium feed.[12]

Plant Design, Engineering, and Construction

The need for exceptional speed in both design and construction of the thermal diffusion plant, designated S-50 for security reasons, was an important consideration in Groves's selection of the H. K. Ferguson Company as the prime contractor. In earlier defense projects, the Manhattan commander had been greatly impressed with the Cleveland firm's ability to complete a job on schedule. Against the advice of his advisers, who thought six months was an optimistic schedule, Groves determined that the plant must be in full operation in four months. Furthermore, the first production unit should begin operating only seventy-five days after start of construction. Groves offered the high-pressure services of Manhattan's Washington Liaison Office for expediting procurement; instructed the company to place its orders without competition and by wire or telephone, using wherever practicable the same manufacturers who had supplied equipment for the Navy pilot plant; and ordered that plant components be identical copies of those developed for Abelson's project.[13]

To further ensure that Ferguson would have access to all available assistance the Army could provide, Colonel Nichols in June 1944 established an S-50 Division in the Manhattan District office. (*See Chart 3*) He assigned Lt. Col. Mark C. Fox as unit chief for the thermal diffusion project and Maj. Thomas J. Evans, Jr., as his assistant, with special responsibility for overseeing plant construction. In anticipation of the need for special measures to enable Ferguson and its subcontractors to successfully carry out the extraordinarily demanding terms of the S-50 contract, Colonel Fox organized an Expediting Branch in the division, which functioned through District procurement officers in industrial centers throughout the United States.[14]

With only a few weeks in which to complete blueprints and let procurement contracts, the Ferguson Company had no alternative but to adhere as closely as practicable to the Naval Research Laboratory design. Ferguson engineers visited the laboratory and the Navy turned over to them all of the drawings and blueprints needed for construction of the columns and racks. They modified Navy designs and developed new ones for certain elements of the auxiliary equipment only to the extent necessary to meet the different conditions existing at the Tennessee location. To save time they based much of the construction on simple field sketches, postponing completion of detailed drawings until after the plant was built.[15]

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[12] Memo, Nichols to Groves, 11 Oct 44, Admin Files, Gen Corresp, 600.12 (Projs and Prgms), MDR; Groves, *Now It Can Be Told*, pp. 120-21.

[13] Groves, *Now It Can Be Told*, p. 121; MDH, Bk. 6, Sec. 3, "Design and Construction," pp. 3.15-3.17, DASA.

[14] MDH, Bk. 6, Sec. 6, "Organization and Personnel," p. 6.2, DASA; Org Chart, U.S. Engrs Office, MD, 28 Aug 44, Admin Files, Gen Corresp, 020 (MED-Org), MDR. When Colonel Fox was assigned to another part of the Manhattan Project in March 1945, Major Evans replaced him as S-50 unit chief.

As laid out in the Ferguson engineers' designs, the plant consisted of 2,142 columns, each 48 feet in height, distributed in twenty-one racks.[16] Each of the columns had three concentric tubes, comprised of a 1¼-inch nickel pipe inside; a slightly larger copper pipe in the middle; and a 4-inch galvanized iron jacket on the outside. In the small (one one-hundredth of an inch) annular space between the outer wall of the nickel pipe and inner wall of the copper pipe the diffusion process would occur. Steam, under a pressure of 100 pounds per square inch and at a temperature of 545 degrees Fahrenheit, would circulate downward through the nickel pipe while water at 155 degrees Fahrenheit would flow upward through the iron jacket; simultaneously, uranium hexafluoride would flow into the base of each column from a reservoir, specially designed to maintain at the bottom of each column a concentration of U–235 approximating that in natural uranium. Designed into the top of each column was a system of freezing coils; this feature eliminated the need for complicated mechanical valves, and would permit plant employees to draw off small amounts of the enriched product at frequent intervals.

All the racks, each with 102 columns, occupied a single main process building, a huge black structure 522 feet long, 82 feet wide, and 75 feet high. Running the full length of the west side of this building was a mezzanine partitioned into eleven control rooms, one for each two racks, and an equal number of transfer rooms containing process equipment for supplying feed material and removing enriched product and depleted uranium hexafluoride from the columns. The engineers designed the final rack with separate control and transfer rooms so that it could be used for employee training and experimental work.

On 9 July 1944, Ferguson workers began clearing the S–50 plant site in the area adjacent to the K–25 powerhouse. In less than three weeks they had completed foundations for the main process building and by mid-August were installing the process equipment. Pipe fitters and welders concentrated on the major task of erecting the twenty-one racks of columns during September and October. Test operations, however, soon revealed that many of the columns leaked at the top and bottom and would require additional welding; yet in spite of this delay, all racks were ready for start-up operations by January 1945 and became fully operational by mid-March. In the meantime, the District had closed out the Ferguson construction contract, assigning completion of subcontracts for remaining insulation and electrical system work to other firms available in the Clinton area. These subcontrac-

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[15] MDH, Bk. 6, Sec. 3, p. 3.6, DASA.

[16] This and following paragraph based on MDH, Bk. 6, Sec. 4, "Description of Plant," pp. 4.1–4.5, DASA.

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tors also completed auxiliary buildings, including a new S-50 steam plant to supplement the K-25 powerhouse.[17]

Plant Operation

Because time was so short, and to avoid endangering security by bringing in yet another outside firm, General Groves insisted that the H. K. Ferguson Company also operate the plant.[18] At first Ferguson officials objected, stating that as an engineering construction company it maintained a closed shop and, therefore, could anticipate union trouble on its other wartime jobs if it attempted to carry on a nonunion operation at the Clinton Engineer Works, where security regulations prohibited employee unions. But District representatives soon overcame this objection by resorting to a corporate fiction similar to that which had worked so well with the M. W. Kellogg Company on the gaseous diffusion project. They permitted Ferguson to form a wholly owned subsidiary, designated the Fercleve (from the words *Ferguson* and *Cleveland*) Corporation. Fercleve then accepted a letter contract on 1 July (and a formal contract in late 1944), according to which it would procure supplies and materials; train personnel; and inspect, supervise, and operate the thermal diffusion plant in return for a fee of $11,000 a month. To monitor the Fercleve contract, Colonel Fox established an Operations Branch in the S-50 Division.

While Fercleve wasted no time in taking steps to set up an operating organization, its late start presented it with some difficult problems. When company personnel officials attempted to recruit an operating force, they found the other plants had already cut deep into the local labor market. And they could not offer housing on the reservation, a main inducement used by the other operating companies. Problems also arose in Fercleve's efforts to train operators. As a beginning step, the company sent four of its own employees and ten enlisted men from the Manhattan District's Special Engineer Detachment to Philadelphia to receive training from Abelson. This group acquired some experience in conditioning techniques but learned little about operations because the Navy plant was not yet completed. Then, on 2 September, an explosion wrecked a large part of the Navy pilot plant, injuring several of the trainees. This unfortunate incident not only ended the initial training program but also raised for a time some severe doubts concerning the design of the Clinton plant. Subsequently, however, Abelson and fifteen of his experienced staff moved to the Tennessee site, where they gave valuable assistance, first in conditioning the production plant and then in getting it into operation.[19]

In spite of recruiting difficulties, Fercleve by April 1945 had an operat-

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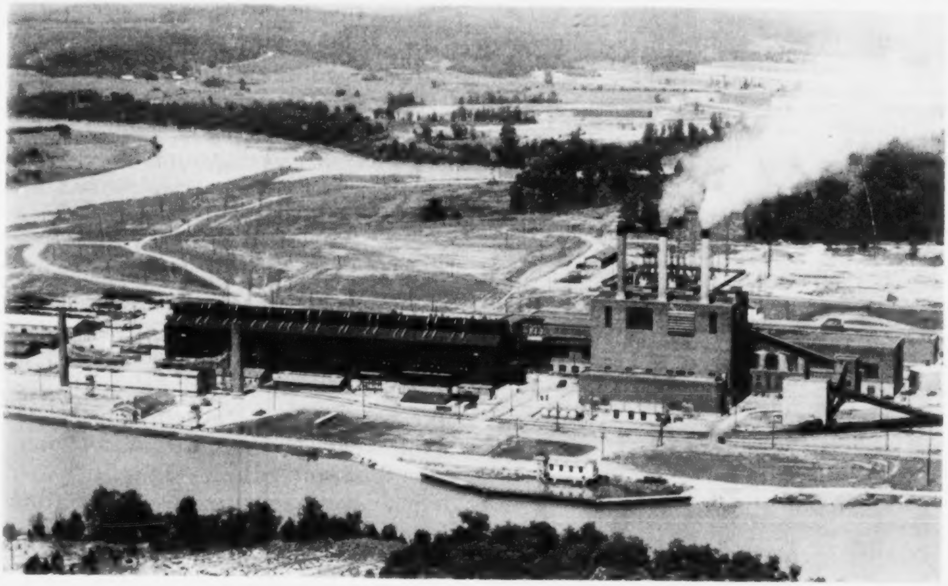
[17] Ibid., Sec. 3, pp. 3.18–3.20, DASA. To equip this boiler plant, the District acquired twelve surplus boilers from the Navy, fabricated for use in destroyer escort vessels, and the Washington Liaison Office secured a number of 25,000- and 482,000-gallon tanks from excess Army stocks.

[18] Except as otherwise indicated, section based on ibid., Sec. 5, "Operations," DASA; Org Chart, U.S. Engrs Office, MD, 10 Nov 44, MDR. See also Groves, *Now It Can Be Told*, p. 120, n. 8.

[19] Groves, *Now It Can Be Told*, p. 122.



Liquid Thermal Diffusion Plant *(long, dark building)* at CEW. *The adjacent K–25 power plant drew water from the Clinch River.*

ing force, exclusive of military personnel, of about 1,600 at the Clinton Engineer Works. In addition, Special Engineer Detachment enlisted personnel, comprised primarily of men trained in engineering or science, served as operators and supervisors in the plant, their number reaching a total of 126 at the height of operations.

While plant construction was still in progress, Fercleve crews began conditioning Rack 21 for start-up operations. When they opened the valves to let high-pressure steam from the K–25 power plant flow into the rack, great quantities escaped with an ear-splitting noise, and parts of the rack were soon shrouded in hot vapor. Under ordinary conditions such clearly demonstrated indications of defective equipment would have resulted in an immediate shutdown. But faced with Groves's insistence that the first units must be in operation by early fall, Fercleve's plant manager had no choice but to proceed with start-up activities. Consequently, in the last months of 1944, operating personnel pressed ahead with start-up of additional racks, and soon plant employees came to accept the noise of escaping steam, accompanied by great clouds of vapor, as almost normal operating conditions.

There can be little doubt that the haste to get into production increased already inherent operating hazards in the thermal diffusion plant. In the confined spaces of the diffusion columns, high-pressure steam and uranium hexafluoride, which expanded 35

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BILLBOARD AT THE S-50 PLANT SITE

percent in passing from a solid to a liquid, created highly explosive forces. During the period of full operation, the plant did have a somewhat higher accident rate than the other Manhattan production units, but the incidence of really serious accidents was not as great. Most were attributable to lack of training and the inevitable confusion occasioned by construction and operating crews having to work in the same area simultaneously.[20]

During the first months there were times when results scarcely seemed to justify the risks. The combined disadvantages of largely inexperienced personnel and numerous equipment deficiencies seemed to forebode many months of low output and work stoppages before the plant attained an acceptable level of production. Thus, Colonel Nichols reported to General Groves that total output in October 1944 was only a token 10.5 pounds of uranium containing 0.852 percent U-235. While production increased to 171.8 pounds in November, it fell back to 20 pounds the following month, when steam leaks forced numerous shutdowns. With six racks in operation during the first half of January 1945, production for the first time approached predicted levels, but shutdown of some of the K-25 steam units for repairs in the last half of the month reduced output again. February production reached a total of 3,158 pounds in spite of an inadequate steam supply—an anticipated deficiency eventually overcome through the prompt construction of the S-50 steam plant. In the spring and early summer of 1945, plant output went up rapidly, reaching a peak of 12,730 pounds in June. It dropped back briefly in July because of the changeover to the S-50 steam plant, but by that time the thermal diffusion process had served its purpose for the wartime program. The slightly enriched material it produced—sent first to the electromagnetic plant for further enrichment and then, beginning in late April 1945, directly to the gaseous diffusion plant—added enough to the total output of U-235 to guarantee a sufficient amount for one bomb of an appropriate design by the end of July.[21]

Operational studies made after the surrender of Japan in August 1945 showed that, except in an emergency, the gaseous diffusion plant, which was just approaching full production, could henceforth handle the lower degrees of enrichment alone and do it more economically than the thermal diffusion plant. Consequently, operating crews made preparations for shutting down the thermal plant. After continuing in production long enough to extract the last product from material remaining in the columns, the plant ceased operating on 9 September 1945, less than a year after its first unit had started up in the fall of 1944.[22]

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[20] For data on injury rates on the thermal diffusion project as compared with those on the other Clinton projects see MDH, Bk. 6, App. D8, DASA. See also Ch. XX.

[21] Dist Engr, Monthly Rpts on DSM Proj, Jul 44–Jul 45, passim, OCG Files, Gen Corresp, MP Files, Fldr 28, Tabs A and B, MDR; Smyth *Report*, p. 147; Hewlett and Anderson, *New World*, pp. 299–301.

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[22] Dist Engr, Monthly Rpt on DSM Proj, Sep 45, OCG Files, Gen Corresp, MP Files, Fldr 28, Tab B, MDR.

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CHAPTER IX

The Pile Process

Of the three fissionable materials production processes (electromagnetic, gaseous diffusion, and pile) endorsed by the Military Policy Committee in 1942 for full-scale development, the greatest gamble of all appeared to be the pile method, primarily because of a number of difficult technical problems facing project scientists.[1] Experimentation with research piles at the University of Chicago's Metallurgical Laboratory had revealed that plutonium production on a large scale would require the design and engineering of special process techniques and equipment to cope with radioactivity and energy, mostly in the form of heat, more intense and pervasive than ever before encountered in an industrial process. Similarly, investigations into the chemical separation of plutonium from the transmutation residual of natural uranium and highly radioactive fission products had demonstrated that there were still many unanswered questions as to the best way to carry out this ancillary phase of plutonium production.

The Military Policy Committee had taken these problems into account when it decided in December to proceed with mass production of plutonium. Several factors contributed to this affirmative decision. The committee was much impressed by the progress of research and development in the plutonium process at the Metallurgical Laboratory and elsewhere, and also was convinced that the vast potential of the process warranted the undoubted risks inherent in its development. From a military standpoint, project scientists told the committee, the process would produce not only fissionable material for an atomic weapon but also, as a by-product, radioactive fission materials that probably could be utilized as an exceptionally deadly chemical warfare weapon. Even if the scientists and engineers failed to develop the process in time, the plutonium pile with its enormous capabilities for producing heat could become a major source of power for peacetime uses. Given all of these considerations, the Military Policy

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[1] MPC Rpt, 15 Dec 42, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab B, MDR. The original nuclear reactor that Fermi and his scientific colleagues constructed at the University of Chicago's Stagg Field in late 1942 consisted of a cubic lattice of lumps of uranium and graphite piled one layer upon another. Hence, the structure came to be called a pile, a convenient designation for reasons of security because it did not reveal the purpose of a chain-reacting system. The term nuclear reactor did not come into general use until after the end of World War II.

Committee could see no alternative to continuing full-scale development of the process.

Research and Development: Metallurgical Laboratory

Following consolidation of most plutonium research and development at the Metallurgical Laboratory in February 1942, Director Arthur Compton formed an organization that consisted of an engineering council, headed by chemical engineer Thomas V. Moore from industry, and nine major divisions—physics, theory, technical, chemistry, pilot plant, fast neutron, clinical-biological (subsequently health) physics, defense measures, and engineering.[2] One of these divisions, fast neutron, was actually located at the University of California, Berkeley, with work in progress at several other institutions. Other divisions, too, had some aspects of their work under way at other sites (for example, chemistry, at Iowa State, where metallurgist Frank Spedding was testing the metallurgical properties of uranium; and at California, where chemist Glenn Seaborg was investigating the virtually unknown chemistry of plutonium).

Under Compton's supervision and direction, the Metallurgical Laboratory scientific staff moved ahead effectively with devising and testing pile and chemical separation designs for a large-scale plutonium production plant. With this experimental activity proceeding apace, Compton reported to District Engineer Marshall the pressing need for additional research facilities. Marshall immediately contacted Stone and Webster and had the firm draw up plans to expand the laboratory's physical facilities, directing that subcontracts be let to Chicago area construction companies. At the same time, Deputy District Engineer Nichols worked out with Compton the land and building requirements for the Argonne Forest pilot plant site, located southwest of the city, and cleared the way for its acquisition by the Corps of Engineers' Great Lakes Real Estate Office.

By the fall of 1942, the Army had become an active partner in the Chicago program. To provide liaison with the Manhattan District, as well as to assist Compton in procurement and personnel matters, Marshall opened the Chicago Area Engineers Office in the University of Chicago's

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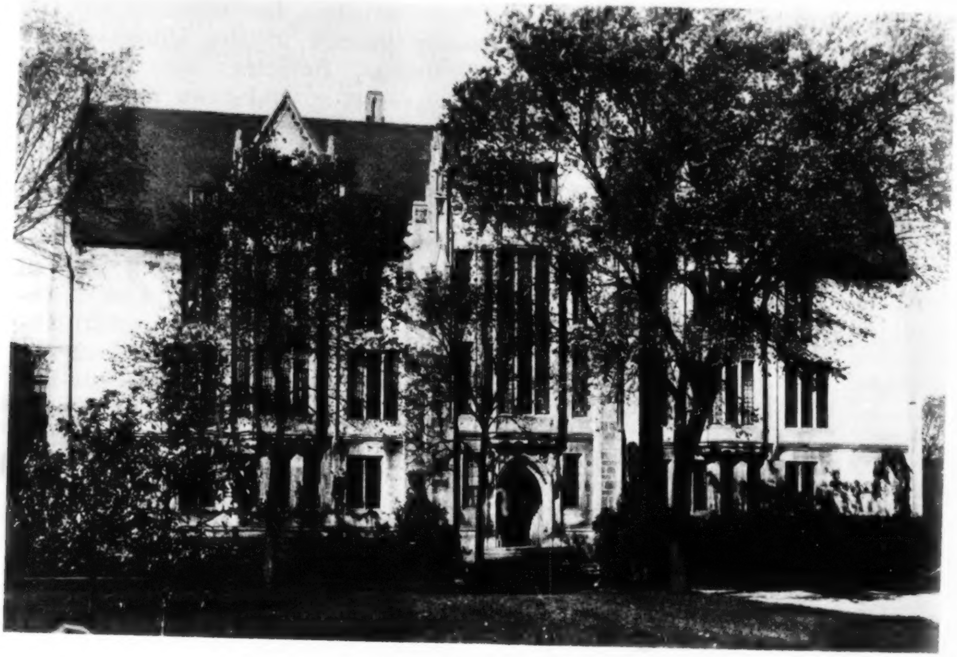
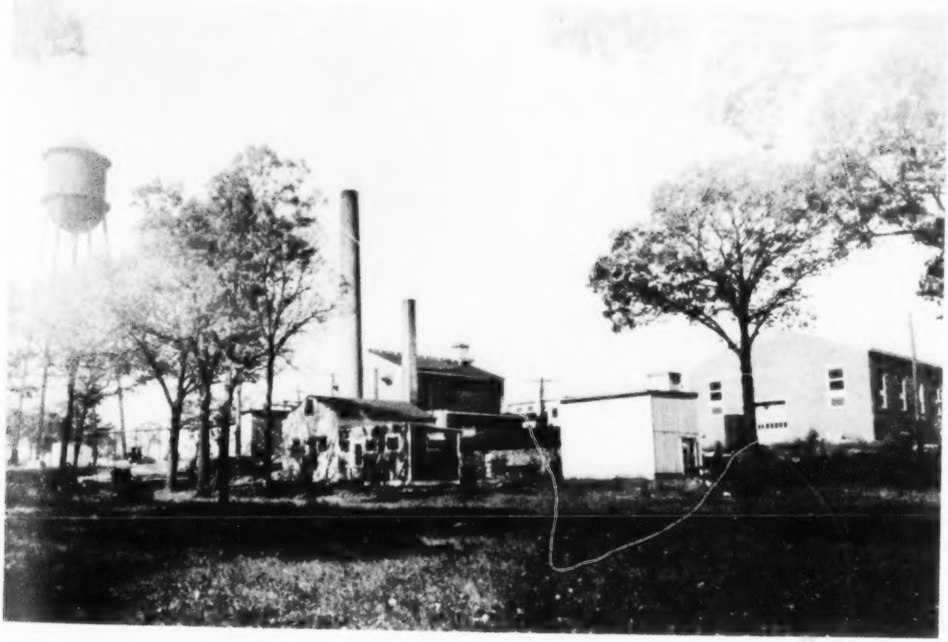
[2] Section on Metallurgical Laboratory based on Org Chart attached to Rpt, Capt Arthur V. Peterson, sub: Visit to Chicago Proj, 29 Sep 42, Admin Files, Gen Corresp, 600.12 (misfiled under Therm Diff Proj), MDR; Memo, Maj Peterson to Groves, sub: Met Proj Org Chart, 14 Oct 43, Admin Files, Gen Corresp, 201 (Gen), MDR; Smyth *Report*, pp. 63–65 and 92; Interv, Author with Norman Hilberry, 3 Jan 63, CMH; MDH, Bk. 4, Vol. 2, "Research," Pt. 1, pp. 2.5–2.8, 7.1–7.3, Apps. B3, B5–B7, D2 (Constr Rpt Extracts), DASA; Completion Rpt, Stone and Webster, sub: Clinton Engr Works, Contract W–7401–eng–13, 1946, pp. 6–11, OROO; Rpt, Compton, sub: Opn of Met Proj, by Univ of Chicago, and Ms, Compton, sub: "Mr. Fermi, the Argonne Laboratory and the University of Chicago," both 28 Jul 44, Admin Files, Gen Corresp, 080 (Argonne–Univ of Chicago), MDR; Tables (Employment by MD on Design, Research and Constr as of 31 May, 31 Jul, and 31 Oct 43) in Rpt, sub: MD Proj Data as of 1 Jun 43 (most items as of 1 Jun 43, but tables appear to have been added at a later date), Admin Files, Gen Corresp, 600.12 (Projs and Prgms), MDR; DSM Chronology, 13–14 Sep 42, Sec. 2(a), OROO; Compton, *Atomic Quest*, pp. 82–86, 110–11, 114–15, 151–52, 157, 170–71, 185–86; Marshall Diary, 25 Jun–5 Sep 42, OCG Files, Gen Corresp, Groves Files, Misc Recs Sec, behind Fldr 5, MDR; Interv, Author with J. M. McKinley, 4 Jan 63, CMH. Captain McKinley served as deputy area engineer at Chicago from about November 1943 to July 1945 and as area engineer until about November 1945.



University of Chicago Physics Building

physics building, which was adjacent to Compton's own headquarters and the laboratory's administrative and business offices, and assigned Capt. James F. Grafton as area engineer. Shortly thereafter, the decision to reduce Stone and Webster's responsibilities for Metallurgical Laboratory construction to limited architectural and engineer services shifted much of the burden of administering the expansion program upon Captain Grafton and his modest staff. The increased work load of letting and overseeing the great number of University of Chicago subcontracts forced Grafton to enlarge his staff, which gradually increased in size from nearly 100 in the summer of 1943—when the Army took over all OSRD-sponsored research and development contracts—to a total of approximately 250 in July 1945. To provide additional space for the expanding Chicago area staff, the Manhattan District leased the state of Illinois' massive grey 124th Field Artillery Armory, located only a short distance from the university campus. Sharing the quarters with the area engineer's staff were the laboratory's administrative personnel, an arrangement that facilitated closer coordination between the two groups in such matters as security, labor and materials procurement, personnel, priorities, patents, and finances.

During the Metallurgical Laboratory building and remodeling program, which continued uninterrupted until



ARGONNE LABORATORY NEAR CHICAGO, *one of the Metallurgical Project's research facilities.*

late 1944, the Chicago Area Engineers Office oversaw construction that provided the Chicago program with more than 500,000 square feet of space, including an entirely new chemistry building with an annex, several new buildings at the Argonne site, and extensively remodeled facilities in existing structures, all at an ultimate total cost of about $2.15 million. In carrying out this expansion, the Army received the constant and effective support of the University of Chicago's administrative staff, which consistently adhered to the policy set forth at the beginning of the program in 1942, namely, that it would "turn the University inside out if necessary to help win the war. Victory is much more important than survival of the University." [3]

Pile Design

In late 1942, as Army leaders gradually became more familiar with the plutonium phase of the atomic bomb project, they realized that progress in pile development at the Metallurgical Laboratory was likely to be the key factor determining how soon large-scale production of fissionable material would be possible.[4] In

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[3] Rpt, Compton, sub: Opn of Met Proj by Univ of Chicago, 28 Jul 44, MDR.

[4] Subsection on pile designs based on Rpt, Peterson, sub: Visit to Chicago Proj, 29 Sep 42, MDR; Min, Conf at Met Lab, 15 Oct 42, Admin Files, Gen

Continued

124TH FIELD ARTILLERY ARMORY IN CHICAGO

September, General Groves, newly appointed as Manhattan commander, sent Capt. Arthur V. Peterson, a civil engineer by profession, to visit the Chicago scientists. Then using the detailed information in Peterson's report as a guide, Groves arranged a series of personal visits to Chicago in early October, during which he attended the policymaking meetings of the Metallurgical Laboratory Technical Council and conferred with members of its engineers and scientific staff.

The Manhattan commander was impressed with the way in which Comp-

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Corresp, 337 (Univ of Chicago), MDR; Min, Tech Council, 5 Oct 42 (Rpt CS-286), 12 Oct 42 (Rpt CS-294), 13 Oct 42 (Rpt CS-306), 15 Oct 42 (Rpts CS-309 and -311), 23 Dec 42 (Rpt CS-397), 22 Jan 43 (Rpt CS-414), ANL; MDH, Bk. 4, Vol. 2, Pt. 1, pp. 3.1-3.16, and Pt. 2, pp. 4.2-4.7, and Vol. 3, "Design," pp. 5.14-5.35, DASA; Hewlett and Anderson, *New World*, pp. 174-82 and 193-98; Smyth *Report*, pp. 42, 75, 81-83; Groves Diary, 5, 10, 15 Oct 42, LRG; Groves, *Now It Can Be Told*, pp. 40-41 and 80-81; DSM Chronology, Nov-Dec 42, passim, OROO; Memo, Peterson to Nichols, sub: Reassessment Sess at Chicago (12/2/42), 4 Dec 42, Admin Files, Gen Corresp, 410.2 (Uranium), MDR; MPC Rpt, 15 Dec 42, MDR; Rpt, Mtg with Greenewalt, 24 Feb 43 (Rpt CS-2644), ANL; Ltr, Greenewalt to Groves, 8 Jul 43, Admin Files, Gen Corresp, 080 (Argonne-Univ of Chicago), MDR; Compton, *Atomic Quest*, pp 161-63 and 167-70; Completion Rpt, Du Pont, sub: CEW, TNX Area, Contract W-7412-eng-23, 1 Apr 44, p. 303, OROO; Dist Engr, Monthly Rpt on DSM Proj, 23 Mar 43, OCG Files, Gen Corresp, MP Files, Fldr 28, Tab A, MDR. For a detailed discussion of the plutonium production process, see appropriate volumes in Division 4, *Plutonium Project*, of the National Nuclear Energy Series.

New Chemistry Building, Metallurgical Laboratory, *on the University of Chicago campus. Barely visible is the gothic tower (at far left) of the football stadium where Enrico Fermi achieved the first chain reaction in a graphite pile.*

ton had organized the laboratory and with the exceptional capabilities of the scientific staff. He indicated his general approval of the research program, expressing but one major criticism: The program was not moving fast enough to permit a decision on which proposed pile design should be adopted for full-scale development. If necessary, he said, the research scientists should develop more than one design, regardless of the cost, because the earliest start possible on detailed design and construction was tremendously important. Groves recalled later that he had quickly concluded that "the plutonium process [of all the methods proposed] seemed to offer . . . the greatest chances for success in producing bomb material." [5]

At the time of Groves's first visits, Metallurgical Laboratory scientists had achieved only limited progress in transforming the results of pile research into concrete blueprints for pile design. Seriously handicapped by the lack of pure uranium metal in the quantities needed for essential experiments, the research teams barely had made a start on a program for pile development that called for pile design and engineering in three stages: a 10,000-kilowatt experimental unit, to ascertain whether a chain reaction could be sustained; a 100,000-kilowatt pilot pile, to test helium cool-

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[5] Groves, *Now It Can Be Told*, p. 41.

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ing and the mechanical techniques of loading and discharging; and a second 100,000-kilowatt pile, also helium cooled, to be the first unit of the large-scale production plant. Each of these piles would employ graphite, now available in ample quantities from commercial sources, as a moderator. The pile designers would have preferred heavy water, which combined in a single element the moderating and cooling factor required, but its continuing scarcity made design of a pile employing that hydrogen isotope impractical.

Groves found, too, that project scientists had not reached agreement on what was, in some respects, the most crucial problem in pile design—how safely and efficiently to disperse the intense heat that would be produced by the fissioning process in a high-wattage pile. Under the three-stage plan, Compton had given helium cooling a priority position. At the same time, however, physicists Eugene Wigner and Leo Szilard, as well as other staff scientists, were still giving serious consideration to a number of other coolants, including diphenyl and bismuth.[6] Even water, with its corrosive reaction to uranium and high-neutron absorption, could not be discounted.

Groves and the Manhattan District officers who visited the Metallurgical Laboratory in the fall of 1942 quickly learned that the feasibility of all pile designs would have to remain in doubt until physicist Enrico Fermi and his colleagues had completed construction of an experimental pile capable of a sustained chain reaction and also had accurately measured the neutron-absorbing characteristics of each pile component (lattice, controls, loading and unloading mechanism, shielding, and coolant). At this stage the pile researchers felt that attaining a state of criticality was possible with a properly designed and assembled lattice of sufficiently pure graphite and uranium metal. But what they were uncertain of, and could not ascertain until a chain reaction was set going, was the actual size of the multiplication factor *k*—the excess number of neutrons above unity required to barely sustain fissioning in a critical pile. And lacking this data, design engineers found themselves not knowing how much leeway they had in selecting the materials for the mechanical structure and coolant system of the large-scale production piles.[7]

Spurred by the Army's insistence on moving into engineering and construction as rapidly as possible and by the impending participation of E. I. du Pont de Nemours and Company as a full-time partner of the Metallurgical Laboratory, Compton and the pile researchers decided to modify earlier plans. Under the revised program, Fermi and his staff were to complete as quickly as possible a low-powered pile, to demonstrate the feasibility of a chain reaction and furnish the much-needed data about the *k* factor;

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[6] Diphenyl is a white crystalline hydrocarbon that melts at 160 degrees Fahrenheit and readily conducts heat. Bismuth (Bi–83) is a grayish white metal, with a reddish tinge, that absorbs relatively few neutrons and, like diphenyl, has a low melting point.

[7] Criticality, or critical size, in a pile fueled with uranium may be defined as the condition in "which the number of neutrons produced in the fission process just balances those lost by leakage and by capture." See Glasstone, *Sourcebook on Atomic Energy*, p. 518, par. 14.45.

and another team was to begin work on a second pile of low wattage at the Argonne site, to provide project chemists with the additional small quantities of plutonium they urgently needed to test methods and equipment for separating the element. Pile designers now would design only a single 100,000-kilowatt helium-cooled pile capable of producing an estimated 100 grams of plutonium daily; this pile, they hoped, would function as both the testing unit and the first unit of the full-scale production plant. Finally, they were to continue testing designs for piles cooled by water, diphenyl, and bismuth.

Fermi, achieving the historic first sustained chain reaction on 2 December,[8] found that the *k* factor was considerably larger than he had anticipated. This discovery removed a chief objection to water, diphenyl, or even air as a coolant in high-powered piles, since the greater margin of *k* would permit more neutron absorption without reducing the efficiency of pile operation. Also, the larger *k* factor indicated a much greater choice in materials of coolant pipes, the control mechanism, and for load and discharge equipment.

Nevertheless, in view of the advanced status of the helium-cooled pile design, both Du Pont and the Army continued to favor its development as the prototype for the production units, even though Fermi's new data and other Metallurgical Laboratory scientists' encouraging research into alternate methods had made liquid or air cooling seem far more feasible. By the time the Military Policy Committee decided on 10 December to shift the location of the large-scale plutonium production plant from the Clinton Engineer Works in Tennessee to a more isolated area, preliminary designs for the 100,000-kilowatt helium-cooled pile were sufficiently complete to provide the Army with the requisite criteria not only for determining the safety, power, water, and other site requirements but also for compiling the specifications list of materials.

An unresolved point of concern to project engineers, especially those from Du Pont, was the feasibility of operating a graphite-moderated pile on an industrial scale, whether cooled by helium or any other type of coolant. Because so many technical uncertainties still remained, Du Pont scientists emphasized to Groves the need for developing an alternate pile design, as insurance against total failure, and expressed particular interest in the technical and engineering advantages of a pile that could be both moderated and cooled with heavy water. The Military Policy Committee, therefore, decided to continue the heavy water research already in progress, recommending the expansion of heavy water facilities. Some weeks earlier, Du Pont had suggested that the manufacture of heavy water by the distillation method could be carried out by modifying certain facilities at the Morgantown (West Virginia), Wabash River (Indiana), and Alabama Ordnance Works, where the company was manufacturing munitions for the government. Consequently, in late December, Groves approved negotiation of contracts with

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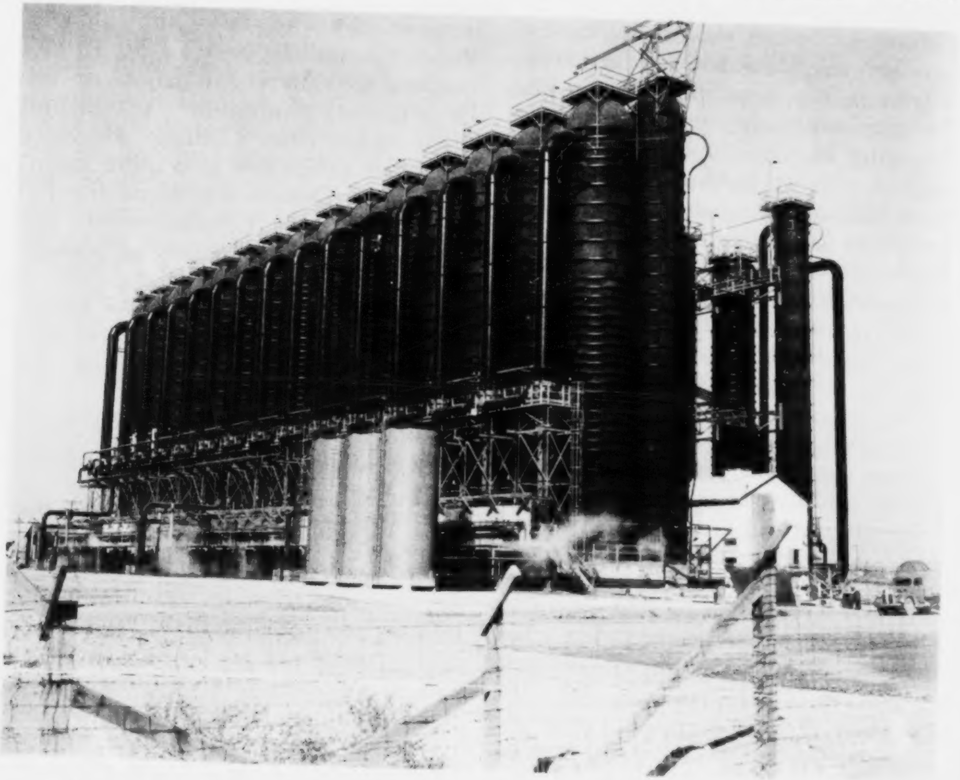
[8] See Ch. V for a fuller description of the historic first sustained chain reaction on 2 Dec 42.



Heavy Water Production Plant at the Wabash River Ordnance Works

Du Pont to build and operate heavy water plants at these facilities. (*See Map 2.*)

From the standpoint of pile engineering development, completion of a pile design as quickly as possible was a matter of considerable importance to Du Pont. In January 1943, Du Pont was still giving first priority to the helium-cooled pile for the production plant, even though company designers were experiencing little success in resolving complex technical problems. A hopeful portent, however, was Fermi's latest research finding into the value of *k*, which revealed that the margin of neutrons in a uranium-graphite pile was probably sufficient to make either liquid or air cooling feasible on a large scale. Encouraged by Fermi's data, Wigner and his research team had pushed ahead on designs for a water-cooled production pile and were able to complete acceptable preliminary blueprints by early January. At the same time, also partly in response to Fermi's revelation, a team of Du Pont and Metallurgical Laboratory engineers and scientists began intensive work on design of an air-cooled pilot pile of moderate wattage. In spite of minor difficulties, the team completed virtually all pile engineering designs and specifications by the end of April. That same month, in accordance with the earlier decision to move the location of the plutonium semiworks from Chicago to Clinton, Du Pont commenced pile construction at the Tennessee site.

Meanwhile, Wigner's group submitted the preliminary designs for the water-cooled production pile to Du Pont. Du Pont engineers at first were skeptical about the feasibility of the water-cooled pile, because they seriously doubted the problems of leakage and the water's corrosiveness could be overcome; however, continuing problems with the helium-cooled pile designs finally persuaded them that Wigner's pile might be the answer for the plutonium production plant. Terminating all helium pile research in mid-February, Du Pont design teams worked at an accelerated pace through the spring, summer, and early fall to complete blueprints for a water-cooled pile. In October, as the early stages of building the plant at the Hanford site in south central Washington State were rapidly nearing completion, delivery of the design specifications precluded serious delays in meeting pile construction schedules.

Chemical Separation Process Design

In the fall of 1942, the problems of developing the second stage of the plutonium production process—the chemical separation of the new element from irradiated uranium—appeared less formidable to General Groves and Du Pont officials than those relating to development of the pile and separating the isotope U-235 from U-238, because chemical separation generally involved techniques already familiar to chemists and chemical engineers. But time proved this optimism was not warranted; project scientists and engineers spent almost as long developing an industrial-scale separation process as they did to complete design and engineering of a pile production process. Since the beginning of the year, research teams at the Universities of Chicago and California, Berkeley, and at Iowa State College had worked without letup to design a suitable separation process. Handicapped at first by the unavailability of more than microgram quantities of plutonium, the teams had tested a variety of methods, all of which had required handling the intensely radioactive byproducts by remote control. Deciding finally in favor of a precipitation process employing lanthanum fluoride in solution as the carrier, project chemists convened in Chicago on 15 October to present the results of their research to representatives of the Army, Du Pont, and Stone and Webster.[9]

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[9] For a fuller account of development of a process for the chemical separation of plutonium consult Met Lab Monthly Rpts, CN-114, -239, -250, -261, -299, -343, -359, -419, -421, mostly 1942, ANL; Min, Lab Council (Met Lab), 31 May 43 (Rpt CS-

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General Groves, Colonels Marshall and Nichols, and Captain Grafton joined with officials from the two firms serving as prime contractors on the plutonium project and members of the Metallurgical Laboratory staff to hear leaders of the separation process research teams describe why they believed the lanthanum fluoride method was feasible for a large-scale production plant. Impressed by the practicality of the research teams' proposed separation process based on the precipitation method, both Army and industry representatives approved going ahead with further tests. They also were duly impressed by the evidence of intense radioactivity in the separation process, a fact that subsequently contributed to the Military Policy Committee's decision in December to shift the plutonium production plant from Tennessee to another location.

As further research in the winter and spring of 1943 revealed that lanthanum fluoride presented certain chemical problems not previously discerned, project scientists began testing other substances and found that bismuth phosphate gave the best results. In May, Du Pont managers decided in favor of designing the chemical separation units at the Clinton semiworks and the Hanford production plant to employ bismuth phosphate, with the possibility of lanthanum fluoride as a backup choice, because both chemicals could be employed in the same type of equipment.

Du Pont Collaboration and Other Problems

Steady progress on development of pile and chemical separation process designs in early 1943 demonstrated the basic validity of the Army-orchestrated arrangements for collaboration between the Metallurgical Laboratory and Du Pont. On occasion, however, some differences surfaced between the two organizations that posed a possible threat to fully effective joint cooperation. When such instances occurred, the Army promptly intervened and endeavored to provide the direction and guidance essential to maintaining viable collaboration. In January, for example, Major Peterson, who recently had replaced Captain Grafton as the Chicago area engineer, joined with Compton in developing a plan to move the first chain-reacting pile from the University of Chicago's West Stands squash court to the Argonne site. Fermi and his fellow scientists wanted to keep the pile on campus; however, Army and Du Pont officials considered pile operation in the heavily populated university district much too hazardous. A short time later, the Army also acted as arbitrator for Du Pont and the University of Chicago, securing an agreement from the latter that it would operate the Clinton semiworks.

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694) and 3 Jul 43 (Rpt CS-749), ANL; Min, Conf at Met Lab, 15 Oct 42, MDR; DSM Chronology, 14 Dec 42, Sec. 25, OROO; MDH, Bk. 4, Vol. 2, Pt. 1, pp. 6.1–6.8, and Pt. 2, 5.2, and Vol. 3, pp. 6.5–6.6 and 6.9, DASA; Smyth *Report*, pp. 71–73, 86–88, 97–100; Compton, *Atomic Quest*, pp. 50–52, 55–56, 100–101, 175–76; Groves, *Now It Can Be Told*, pp. 41–42; Glenn Seaborg, *The Transuranium Elements* (New Haven: Yale University Press, 1958), pp. 20–27; Hewlett and Anderson, *New World*, pp. 182–85 and 204–05.

Maj. Arthur V. Peterson

While collaboration between the Metallurgical Laboratory and Du Pont proceeded harmoniously on most matters, the emergence of seemingly innocuous misunderstandings in February portended more serious disagreement in the future.[10] One of the first "minor" disputes erupted over a question on the extent the physicists who had designed the water-cooled pile at the Metallurgical Laboratory should participate in drawing up the detailed engineering blueprints and specifications for the production plant. Crawford H. Greenewalt, Du Pont's liaison representative to the Metallurgical Laboratory, pointed out that Du Pont's customary policy was to rely primarily upon its own staff for detailed design and that, while Du Pont would want to have continued access to the Chicago scientists for occasional assistance, the initiative in requesting such help should come from the company. Eugene Wigner, who had considerable training in engineering as well as physics, disagreed. He contended that his team was entitled to an active role. When Wigner learned Du Pont did not plan to invite his group to Wilmington, he concluded that his own earlier expressed opposition to having the firm participate in the plutonium project was the reason. He offered to resign as group leader, hoping that would clear the way for the rest of his team to go to Wilmington. Compton explained that Du Pont's action was customary practice and not motivated by any personal objection to the scientist. While Wigner's suspicions were not entirely allayed, he agreed to continue with the project. He stayed only briefly in Wilmington, however, and then returned to Chicago, where Compton diverted him to the expanding heavy water pile program.[11]

The Wigner incident pointed up a major problem for the Army in administering the Manhattan Project. As development of a process moved from basic research into engineering, construction, and operations, many of the scientists were no longer needed. Yet Manhattan leaders had to have ready access to the fundamental knowledge and skills of these scientists. For security reasons, too, scientists who had become privy to important aspects of the program could not simply be released and sent back to the colleges and universities. One solution was to transfer them to laboratory positions at Clinton, Hanford, Los Alamos, or to the staff of industrial firms under contract to the project. But for the majority who must be retained on the staff of basic research organizations like the Metallurgical Laboratory, there had to be continuing programs of meaningful research and development. In such a novel and relatively undeveloped field, devising useful research projects was not difficult; the problem was to keep the always limited resources in manpower and materials channeled into those projects that would contribute most directly to the ultimate production of atomic weapons.

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[10] Memo, Compton to Groves, sub: Opn of Piles I, II, and III, 19 Jan 43; Memo, Compton to Groves, sub: Chain-reacting Unit on Univ of Chicago Campus, 2 Feb 43; Rpt, Compton, Fermi, and Robert S. Stone (Clinical-Biological Physics Div chief, Met Lab), sub: Public Hazards at West Stands, 3 Feb 43. All in Admin Files, Gen Corresp, 600.12 (Projs and Prgms), MDR. Hewlett and Anderson, *New World*, pp. 200–201. Ltr, Compton to Groves, 5 Feb 43, Admin Files, Gen Corresp, 600.12 (misfiled under Therm Diff Proj), MDR.

[11] Compton, *Atomic Quest*, pp. 168–69; Ltr, Wigner to Compton, 5 Aug 43, Incl to Memo, Peterson to Groves, sub: Dissatisfaction at Met Lab, 13 Aug 43, Admin Files, Gen Corresp, 080 (Labs), MDR.

By spring, Compton found a good compromise solution in the project for design of a heavy water pile, already under way on a limited scale and acceptable to both Du Pont officials and Groves because they viewed it as an essential backup for the Hanford plant. Furthermore, it was of interest to many of the Metallurgical Laboratory scientists. The promise of increasing supplies of heavy water from both Trail (British Columbia) and the Du Pont-operated distillation plants prompted Compton to work out an agreement with Greenewalt and Colonel Nichols that provided for centering all future heavy water research at the Metallurgical Laboratory under the direction of Professor Henry D. Smyth, head of the physics department of Princeton University.[12]

But Major Peterson reported that, in spite of the initiation of the heavy water pile program, Metallurgical Laboratory scientists continued to be discontented with Du Pont's methods and procedures. Many disliked the tedious work of reviewing the detailed blueprints for the Hanford plant, a chore made necessary because the Metallurgical Laboratory had to approve all process designs. When they found errors, they concluded Du Pont was mismanaging pile development. Wigner, too, again complained that Du Pont was not consulting sufficiently with its Chicago counterpart on heavy water pile design, thus delaying its development.

In late June, Groves decided the time had come to deal with what he termed the "scientist problem." In line with a suggestion from the Military Policy Committee, he arranged with President Franklin D. Roosevelt to write a letter, addressed to him but actually intended for the atomic project scientists. Emphasizing first the need for strictest adherence to security in atomic matters (there had been incidents involving scientists, particularly at Los Alamos), the President went on to say that he had placed Groves in complete charge of carrying out "all development and manufacturing aspects of the work." He concluded that "whatever the enemy may be planning, American Science will be equal to the challenge." [13]

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[12] For a detailed discussion of Manhattan Project's heavy water program and heavy water pile development see MDH, Bk. 3, "The P-9 Project," and Bk. 4, Vol. 2, Pt. 1, pp. 3.3-3.14, DASA. Brief discussion in this and following paragraph on the heavy water pile program at Chicago based on Notes on Conf Held at Wilmington, Del., on April 16th, Incl to Memo, Nichols to Groves, 19 Apr 43, Admin Files, Gen Corresp, 337 (Wilmington), MDR; Ltr, Greenewalt to Compton, 12 Jun 43, Admin Files, Gen Corresp, 441.2 (Polymer), MDR; Transmittal Ltr, Compton to P-9 Reviewing Committee Members, sub: Memo on Transmittal of P-9 Rpt, 11 Aug 43, Admin Files, Gen Corresp, 334 (P-9 Reviewing Committee), MDR; Memo, Capt Lawrence L. Grotjan (Columbia Univ Area Engr) to Nichols, 17 Apr 46, Admin Files, Gen Corresp, 201 (Urey), MDR; MPC Min, 9 Sep 43, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; DSM Chronology, 10 Nov 42, Sec. 23(i), OROO; Hewlett and Anderson, *New World*, pp. 201-04; Smyth *Report*, pp. 101-02; Compton, *Atomic Quest*, pp. 99-100; Groves, *Now It Can Be Told*, p. 15, n. 8.

The Manhattan commander made certain this letter received wide circulation among project scientists. In Wigner's group, it appears to have elicited an unfavorable response. "They felt," Peterson reported to Groves, "that it was unfair for the President to give authority to you and that his closing sentence concerning American Scientists being equal to any challenge was a farce since he allowed them neither responsibility nor authority." In the opinion of some members of the group, "the presence of Du Pont and the Army slows the project. . . ." [14]

In early August, General Groves appointed a committee to review the role the heavy water program should have in the atomic bomb project, a step that was, at least in part, also intended to allay dissatisfaction among the Chicago scientists. Headed by MIT Professor (chemical engineering) Warren K. Lewis, with Standard Oil Vice President Eger V. Murphree, physicist Richard C. Tolman, who was Groves's scientific adviser, and Harvard Professor (chemistry) E. Bright Wilson, Jr., as members, the group upheld the Army, Du Pont, and Compton's earlier objectives. They recommended continuation of a relatively modest heavy water pile research program at the Metallurgical Laboratory "as insurance against a possible failure of the Hanford graphite piles to produce 49 [plutonium] at their rated capacity, and secondarily to explore the possibilities of a method for producing 49 which might utilize uranium more efficiently than graphite piles." [15]

By early fall, the scientists' dissatisfaction had declined substantially, partly as a result of the chance they had had to unburden their grievances to members of the committee and partly because the major design phase of pile development was nearing an end. Even Wigner, acceding to Compton's wishes, agreed somewhat reluctantly to continue to oversee work on the heavy water pile. Nevertheless, Compton later recalled that, although the collaboration had achieved basic design of the plutonium semiworks and production plant by late 1943, there remained in the relationship "a

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[13] Ltr (source of quotations), Roosevelt to Groves, 29 Jun 43, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab D, MDR; MPC Min, 24 Jun 43, MDR.

[14] Memo, Peterson to Groves, sub: Dissatisfaction at Met Lab, 13 Aug 43, MDR. Peterson erred in paraphrasing from the President's letter, stating "American Scientists" instead of "American Science."

[15] Rpt, Committee on Heavy Water Work, 19 Aug 43, Att. 2 to MPC Min, 9 Sep 43, MDR.

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state of tension that caused continual concern to those responsible for the success of the undertaking."[16]

Organization for Plutonium Production

In early 1943, General Groves and the Military Policy Committee devoted considerable attention to assisting Du Pont and the Metallurgical Laboratory staff in forming a plutonium production organization. In this organization Du Pont was to have primary responsibility for design, construction, and—except for the semiworks—operation of the plutonium facilities. Because of the uniqueness of the processes involved, the firm's limited experience in dealing with them, and the overall urgency of the bomb project, Du Pont felt its scientists and engineers would need assistance from the Metallurgical Laboratory staff in all phases of the plutonium program. Thus, as the setting for collaboration was about to shift—although in a somewhat altered form—from the design to the construction and production phases, the Army once again had the primary administrative task of preventing fundamental differences in the two organizations' *modus operandi* from interfering with the progress of the program.

Du Pont's TNX Division

At the end of 1942, after analyzing the unusual nature of the problems involved in the plutonium production process and weighing the District's stringent requirements for security and safety, Du Pont established a special organization for plutonium activities within the company itself.[17] Given the designation TNX Division, this new unit functioned as a subordinate element of the company's Explosives Department, which already had designed and was operating a number of government-owned munitions plants. Locating the TNX Division in a regular company department was consistent with Du Pont's decision to organize and administer its plutonium program in accordance with its standard operating procedures, and, concomitantly, because this arrangement helped to conceal the true character of TNX operations, it fully satisfied the District's requirements for project security.

Du Pont's operating procedures differed somewhat from comparable industrial firms in the early 1940's. The company did not have a highly centralized organizational structure and method of operation but was a kind of industrial confederation of semiautonomous departments, each with many of the characteristics of an independent business enterprise. Guided by broad policies laid down by top executives, a general manager administered each department very much in the same fashion as the president of a company, operating under his own budget and making most of the routine decisions. When additional assistance was needed, the manager could get it from Du Pont's permanent auxiliary departments—the Engineering Department, for example—that furnished regularly required services, such as plant construction and personnel recruitment.

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[16] Compton, *Atomic Quest*, p. 169.

[17] Except as otherwise noted, subsection on Du Pont's plutonium organization based on E. I. du Pont de Nemours and Company, *Du Pont's Part in the National Security Program, 1940–1945* (Wilmington, Del.: Du Pont, 1946), pp. 8–9; Rpt, Du Pont, sub: Constr at Hanford Engr Works, Contract W-7412-eng-1, Du Pont Proj 9536, Proj Hist (hereafter cited as Du Pont Constr Hist), 9 Aug 45, Vol. 1, pp. 22–39, HOO; MDH, Bk. 4, Vol. 3, pp. 10.2–10.3 and App. B7, DASA; Groves Diary, 16 Dec 42, LRG; Hewlett and Anderson, *New World*, pp. 187–88.

Consistent with these operating procedures, Du Pont's management turned over to the general manager of the Explosives Department, E. B. Yancey, overall responsibility for most of the company's plutonium program. Yancey, already extensively involved in other wartime projects, delegated direct authority over the program to his assistant general manager, Roger Williams. A chemical engineer with extensive experience in wartime construction for the government, Williams's introduction to the atomic project had been as a member of the Lewis reviewing committee. He now became, in effect, the active head of the TNX Division, with responsibility for Du Pont plutonium activities at Wilmington, Clinton, and Hanford.

Drawing personnel from most of the departments of Du Pont, as well as from company-operated war plants and the Metallurgical Laboratory, Williams organized TNX into two major subdivisions: the Technical Division, which carried out design development in close collaboration with the Chicago and Clinton researchers; and the Manufacturing Division, which advised the Engineering Department on construction of the plutonium facilities and planned and supervised production plant operations. From the Grasselli Chemicals Department, Williams selected chemical engineer Crawford Greenewalt to head the Technical Division. Serving, as General Groves perceived it, "as the bridge between the hard-driving, thoroughly competent, industrial-minded engineers and executives at Wilmington and the highly intelligent but theoretically inclined scientists at Chicago," Greenewalt spent much of his time at the Metallurgical Laboratory and Clinton semiworks and thus left his assistant, George Graves, in charge of routine administration.[18] Williams's choice to head the Manufacturing Division was R. Monte Evans, a production manager of long experience, most recently with the company's Ammonia Department.

The extensive involvement of Du Pont's Engineering Department in the atomic project came about as a result of the company's policy of building its own plants rather than contracting them out to regular construction firms. E. G. Ackart, Du Pont's chief engineer and Engineering Department head, assigned to his deputy, Granville M. Read, primary responsibility for the construction aspects of the plutonium program and to John N. Tilley the vital role of liaison officer to the Explosives Department. Eventually, the Engineering Department committed more than 90 percent of its personnel and resources to plutonium construction.

Metallurgical Project

In 1943, shortly after Du Pont had established its TNX Division, Arthur Compton, faced with the rapid growth of the plutonium research program, extensively restructured and expanded its administrative organization. By October, the plutonium orga-

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[18] Groves, *Now It Can Be Told*, p. 79.

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nization, now designated the Metallurgical Project,[19] comprised the Metallurgical and Argonne laboratories at Chicago; the newly designed Clinton Laboratories (cover name for the plutonium semiworks) at the Tennessee site; and the many research programs under way at other institutions—eventually seventy—in the United States.

Giving up his dual position as chairman of the Metallurgical Laboratory and its Executive Committee (which he abolished), Compton became director of the Metallurgical Project and appointed three associate directors: Norman Hilberry, his former student and longtime personal assistant, as associate director for research;[20] Robert S. Stone, from the University of California at Berkeley, as associate director for health matters; and Wilbur C. Munnecke, from the University of Chicago, as associate director for administration. At the same time, using the Metallurgical Laboratory Technical Council as a basis, he established the policy-making Metallurgical Project Council and, as council members, selected twenty-five leading staff scientists from the subordinate laboratories.

The Metallurgical Project was from its initiation "a novel enterprise" for Arthur Compton, who, even before the reorganization of the plutonium program, had realized that its ultimate success in producing some hundreds of pounds of plutonium for the wartime needs of the atomic project was dependent on coordinating the resources and talents of literally thousands of scientists and technicians. He had made a substantial beginning toward attaining the program objective in 1942 through the organization and operation of the Metallurgical Laboratory, and now he endeavored to assure its success by providing in the Metallurgical Project the organization with the means to carry through to completion the research, development, design, and engineering of the plutonium facilities.

District Area Offices

Starting in late 1942, as the scientific and industrial elements of the plutonium program rapidly expanded, the Army responded by enlarging its own organization for overseeing the program. As each major element began to function, the Manhattan District established an area office for it. By early 1943, area offices were operating in Chicago, Clinton, and Hanford; at Du Pont headquarters in Wilmington, Delaware; at the heavy water plants in British Columbia, West Virginia, Alabama, and Indiana; and at the larger research programs in progress elsewhere in the country, such as at Iowa State College in Ames.[21] (*See Chart 1.*)

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[19] Subsection on Metallurgical Project based on Org Chart attached to Rpt, Peterson, sub: Visit to Chicago Proj, 29 Sep 42, MDR; Memo, Peterson to Groves, sub: Met Proj Org Chart, 14 Oct 43, MDR; Rpt, Compton, sub: Opn of Met Proj by Univ of Chicago, 28 Jul 44, MDR; MDH, Bk. 4, Vol. 1, "General Features," pp. 9.2–9.3, and Vol. 2, Pt. 1, pp. 2.1–2.2, 7.1, App. B5, DASA; Smyth *Report*, pp. 63–65 and 92; Compton, *Atomic Quest*, pp. 82–86 (quotations from p. 84), 157, 170–71, 185–86; Hilberry Interv, 3 Jan 63, CMH.

[20] Hilberry, who served as Compton's personal representative on those occasions when the latter could not carry out some of his many professional commitments, became, in effect, associate director of the entire Metallurgical Project in late 1943, when Compton moved his headquarters to Oak Ridge. Hilberry remained at the Metallurgical Laboratory in Chicago, where he had his office. See Compton, *Atomic Quest*, p. 185.

In the early phases of plutonium development, the Chicago and Wilmington area offices were the largest and most important. And once Du Pont started construction of the plutonium semiworks in Tennessee, the district engineer enlarged Major Peterson's Chicago area responsibilities to include the Clinton installation. After visiting the site, Peterson set up a Clinton branch of his Chicago area office, designating it the TNX Operating Division. In August 1943, when the District headquarters moved from New York City to Oak Ridge, this division became the Clinton Laboratories Division as a result of a major administrative reorganization. Peterson, while continuing as the Chicago area engineer, assumed additional responsibilities as the new division chief but turned over immediate supervision of the plutonium semiworks to his new assistant, Captain Grafton, who had been with the recently abolished Clinton Area Engineers Office, until he (Peterson) could relocate to the Tennessee site. To handle most of the routine administrative services for the Chicago area office, the District headquarters furnished the area office's new division with a token staff of three District officers, five (later nine) technically trained enlisted men, and five civil service employees. By late 1943 and early 1944, with the shift from research and development to construction and operation of the large-scale production plant, the area office at Hanford expanded rapidly while those at institutional research centers reduced their activities and staffs.

The precise character of the administrative relationships between the Chicago, Wilmington, Hanford area offices and the Manhattan District headquarters in Oak Ridge varied considerably. Certain factors, however, tended permanently to influence this relationship. One of these was geography. The stringencies of wartime travel and communications and Hanford's relatively isolated location resulted in the area engineer, Lt. Col. Franklin T. Matthias, having a good deal more administrative autonomy, at least in routine matters, than Peterson in Chicago or Maj. William L. Sapper in Wilmington. Matthias maintained a permanent liaison official, Mr. H. J. Day, in the Oak Ridge office to keep him informed on current Manhattan developments and to serve as a channel for expediting action on Hanford requests. By way of contrast, the Chicago office always maintained a much closer day-to-day relationship with the District headquarters, particularly after Peterson began spending a major part of his time in Tennessee as of late 1943.[22]

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[21] Except as indicated, subsection on area offices based on Org Charts, U.S. Engrs Office, MD, 15 Aug 43, 1 Nov 43, 15 Feb 44, 1 Jun 44, 28 Aug 44, and 26 Jan 45, Admin Files, Gen Corresp, 020 (MED-Org), MDR; Ltr, Groves to Styer, sub: Promotion of Lt Col Franklin T. Matthias, 25 Oct 44, Admin Files, Gen Corresp, 210.2 (Off Promo), MDR; Matthias Diary, Jan–Sep 43, passim, OROO; Du Pont, *In National Security Program*, App. 3B (originally issued as *Stockholders Bulletin*, 24 Aug 45), p. 61; MDH, Bk. 4, Vol. 5, "Construction," Apps. B57–B58, and Vol. 6, "Operations," pp. 18.1–18.6 and Apps. B8–B10, DASA; Compton, *Atomic Quest*, pp. 107–08; Groves, *Now It Can Be Told*, pp. 72–73.

[22] On charts showing the organization of the U.S. Engineers Office, Manhattan District, Oak Ridge, in late 1943, H. L. Day is listed as the liaison officer for the plutonium project. See Org Charts, 15 Aug

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While the Chicago area engineer supervised plutonium research and development activities, the Wilmington area engineer had primary responsibility for monitoring plutonium engineering and design, with a secondary assignment of supervising Du Pont's feed materials program at the company's Chambers Chemical and Dye Works in Deep Water, New Jersey. Design activities centered in Wilmington, where the Du Pont design staff and visiting Metallurgical Project scientists collaborated on the engineering blueprints and specifications for the plutonium facilities in Tennessee and Washington State. Review and approval of these designs before their dispatch to company engineers at the Clinton and Hanford sites constituted the most important tasks of Major Sapper's Wilmington staff, which, much of the time, received assistance from personnel who were temporarily detailed from the Hanford area office. Because close coordination between the Wilmington and Hanford area offices was essential on all matters relating to construction and operation of the production plant, Sapper reported to the district engineer through Colonel Matthias.

A civil engineer with considerable experience in civilian construction, Colonel Matthias recruited both military and civilian personnel, many from other Corps of Engineers projects, to form the operating nucleus (more than five hundred personnel by 1944) of a burgeoning office organization. To complement Du Pont's field construction organization at the Hanford site, Matthias established major divisions to monitor the many construction-related activities of the prime contractor and its numerous subcontractors. Similarly, to reflect the reorientation of plant activities when Du Pont converted its construction organization into one for plant operations, he revamped the Hanford area office by expanding the production division; by forming a new engineering and maintenance operations division; and, to the extent necessary, by reorganizing the security, safety, labor relations, fiscal audits, and community affairs sections.[23]

Army–Du Pont Administration

The Army–Du Pont plan for coordinating and controlling project activities at the Hanford Engineer Works (HEW) illustrates the way in which District and TNX officials went about jointly administering the plutonium production program.[24] On matters of general policy, TNX executives could consult with Colonel Nichols, to whom Groves had given broad responsibility for plutonium construction and production, or, if necessary, directly with Groves—but only after informing Nichols. On nonpolicy matters, TNX officials were to communicate with Colonel Matthias (or, where

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and 1 Nov 43, MDR. Matthias noted in his diary on 2 Aug 43 that Day was going to be located at the Oak Ridge headquarters after 14 August. On the relative autonomy of the Hanford area engineer see Matthias Diary, 12 Sep and 28 Oct 43, OROO.

[23] On the area engineer and Du Pont construction and operations organization at Hanford Engineer Works see MDH, Bk. 4, Vols. 5 and 6, each App. B, DASA; Du Pont Constr Hist, Vol. 1, HOO; Intro to Rpt, Du Pont, sub: Memoranda for File on HEW Opns, 1944–46 (hereafter cited as Du Pont Opns Hist), Sep 46, HOO.

[24] Ltr, E. B. Yancey to Dist Engr, Attn.: Nichols, sub: Corps of Engrs–Du Pont Corresp and Contracts of HEW, 4 May 43, Admin Files, Gen Corresp, 161 (Du Pont), MDR.

appropriate, with Lt. Col. H. R. Kadlec, his construction chief); or Major Sapper at Wilmington; or Maj. James E. Travis at District headquarters, who in 1943 headed the Service and Control Division at Oak Ridge.

On questions relating to nonpolicy matters submitted by Matthias, Kadlec, and other staff members, Du Pont's officials at the Hanford site could make decisions, furnish information, or provide recommendations as they saw fit; when necessary, they could consult with their department or division in Wilmington by teletype. In those instances when the Hanford area engineer or his staff members were dissatisfied with results of inquiries directed to the Du Pont field staff, they were authorized to communicate directly with Roger Williams or Granville Read or with Major Sapper.

Inevitably, many problems arose that could not be readily resolved by the local area engineer, or even by the district engineer, and the majority of these ended up on General Groves's desk in Washington, D.C. Most often they involved important policy decisions or required extensive negotiations with other wartime agencies. For example, during the design and construction phases of the plutonium project, Groves had to deal with problems of electric power supply at Hanford, acute shortages of essential workers at both the Hanford Engineer Works and Clinton Laboratories, deferment of key civilian scientific and technical personnel, and procurement of a great variety of materials and equipment. Groves and his small liaison staff frequently intervened personally to expedite solutions. In a comparatively few cases, problems had to be resolved by the Military Policy Committee or by special reviewing committees that Groves appointed. Typical was the heavy water research and experimentation program, which required an investigation by a reviewing committee and a decision by the Military Policy Committee to determine the scope of this program and the extent of interchange with the Canadians that was permissible.[25]

Beginning in late 1942, the combined efforts of Groves, Compton, Greenewalt, and Williams facilitated effective Metallurgical Project–Du Pont collaboration through an interchange of both expert personnel and scientific and technical information of all kinds.[26] To explain the Metallurgical Laboratory scientists' preliminary helium- and water-cooled pile designs to Du Pont's TNX staff, Compton dispatched the respective pile research teams to Wilmington. While most of the Chicago scientists stayed at Wilmington only for a limited time, at least one young physicist, John A. Wheeler, who was an expert on pile development, became a permanent member of the Du Pont design staff. The design teams from Wilmington that visited the Metallurgical Laboratory in November were the vanguard of many others who, in subsequent months, fol-

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[25] For examples of problems relating to power and labor see correspondence in HB Files, Fldr 51, MDR. The extent of Groves's involvement in solving such problems can be traced in Groves Diary, Apr–Jun 43, passim, LRG. On the heavy water problem see MPC Min, 9 Sep 43, MDR.

[26] Discussion of development of the means for collaboration between the Metallurgical Project and Du Pont based on Groves, *Now It Can Be Told*, pp. 48 and 79–80; Smyth *Report*, pp. 92–93; Compton, *Atomic Quest*, pp. 164–65; DSM Chronology, 25 Nov 42, Sec. 23(a), OROO; Rpt, Whitaker, sub: Conf at Wilmington, 17–18 Dec 42 (Rpt CS-406), ANL.

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lowed periodically to confer with the Chicago scientists about the latest developments in the pile process. Greenewalt, too, regularly spent extended periods in Chicago (and, later, at Clinton) and assigned Du Pont physicist J. B. Miles as his permanent representative at the Metallurgical Laboratory. Both Greenewalt and Miles, when they were in Chicago, attended meetings of the Metallurgical Project Council and regularly conferred with the laboratory group leaders.

The frequent interchange of expert personnel gradually became a key feature of the collaboration, extending eventually to include not only exchanges between the Chicago scientists and Wilmington designers but also between the Wilmington designers and the Clinton researchers, and among the Clinton, Chicago, and Hanford scientific staffs. While Metallurgical Project scientists on occasion complained bitterly that the Du Pont design staff was not consulting adequately with them on some matters, on the whole the interchange appears to have been one of the most essential and profitable aspects of the collaboration.

Consistent with the plan to employ the Metallurgical Project essentially as a Du Pont research and development division, the plutonium project leaders incorporated into the Metallurgical Project–Du Pont work relations agreement certain special provisions to ensure a continuous and adequate exchange of scientific and technical information. The Metallurgical Project scientists regularly sent copies of pertinent reports to the Du Pont design team; in turn, the Wilmington designers kept the Chicago and Clinton researchers fully informed on current layout and process design decisions, all of which then had to be approved by appropriate members of the Metallurgical Project staff. A further interchange occurred when Du Pont submitted completed blueprints and process drawings to the district engineer for the usual contract review. The district engineer, in compliance with the work agreement, then sent the completed designs to the Metallurgical Project staff for final approval of the scientific and technical aspects.

The Semiworks: Clinton Laboratories

In the early months of 1943, while design groups were still developing pile process designs and engineering specifications, Du Pont construction workers began building the plutonium semiworks—in April, for security reasons, officially designated Clinton Laboratories—at the Clinton Engineer Works in Tennessee. The semiworks site, consisting of 112 acres and officially named the X-10 area, lay between two ridges along a small creek in the isolated Bethel Valley, some 20 miles southwest of the town of Clinton and about 10 miles southwest of the planned community of Oak Ridge. Tentative plans for the semiworks (they would be altered and expanded several times during the period of construction) called for an air-cooled uranium-graphite pilot pile and chemical separation plant,[27] as well as an extensive

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[27] Plutonium project officials conceived the Clinton pilot pile and separation plant as a true semiworks for the Hanford production plant; how-

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research laboratory and a number of support, training, and administrative facilities.

Construction

In his February 1943 progress report to General Groves, District Engineer Marshall set 1 July as the construction completion date for the plutonium semiworks.[28] The X-10 pile and separation plant had to be put into operation as quickly as possible, to provide not only the design and operational data for the Hanford production plant but also the small quantities of plutonium so urgently needed for ongoing research and testing. Furthermore, the facilities were required to train key Du Pont employees in the techniques of plant operation.

Pending completion of engineering designs for the permanent installations, and less than a month after Du Pont had signed the letter contract (8 January 1943), company construction crews began building the temporary, service, and utility facilities. In March, other Du Pont crews began work on the permanent installations, starting with the chemical separation plant. Even though Greenewalt, who was supervising design of this plant, had not yet reached a decision on which of several chemical processes would be employed in it, the Wilmington design teams had accumulated sufficient engineering data to permit a start on its basic components. As these neared completion in the late summer, Greenewalt decided to employ the bismuth phosphate separation method, which required installation of miles of pipe as well as other process apparatus. By early fall the chemical plant was ready for test operations, but these could not be carried out until the pilot pile produced irradiated uranium slugs.

Construction work on the pilot pile did not progress as swiftly and expeditiously as that on the separation plant, because the Du Pont design staff did not complete the engineering blueprints for the air-cooled pile until the end of April and crews excavating the pile site unexpectedly struck a large bed of soft clay, necessitating installation of much more foundation work than had been anticipated. It was June before construction crews started pouring concrete for the 7-foot-thick walls of the pile's great outer shell, which would prevent escape of radioactive emissions, and late summer before they completed them. Thousands of holes pierced the front facing of the shell, to permit insertion of uranium fuel slugs. The side and rear walls and the massive top also had numerous openings of varying sizes and shapes, to accommodate experimental and operating equipment built into the pile. The outer shell finished, technicians began to assemble the pile itself, putting

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ever, with the decision to use water to cool the Hanford piles, the air-cooled pilot pile, strictly speaking, lost its function. The officials weighed the possibility of converting the Clinton pile, but finally decided that early production of small quantities of plutonium was more important. Hence, only the separation plant functioned as a true pilot facility. See Smyth *Report*, p. 76; MDH, Bk. 4, Vol. 2, Pt. 2, p. 4.1, DASA.

[28] Subsection on semiworks construction based primarily on Completion Rpt, Du Pont, sub: CEW, TNX Area, 1 Apr 44, OROO; Dist Engr, Monthly Rpts on DSM Proj, Jan–Sep 43, MDR; MDH, Bk. 4, Vol. 2, Pt. 2, pp. 2.1–2.10, DASA; Hewlett and Anderson, *New World*, pp. 207–10.

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into place hundreds of carefully machined graphite bars to form its inner core—a structure measuring 24 feet square and weighing an estimated 1,500 tons. In the meantime, other workmen constructed the four-story concrete and wood building to house the pile and its auxiliary facilities—a control room, a small "hot" laboratory equipped to handle radioactive materials, and a core removal area.

In spite of constant pressure by General Groves on Du Pont's Engineering Department, completion of the Clinton Laboratories was slow, primarily because of the extent of the support and training facilities the semiworks required. Because of the isolation of the Bethel Valley X-10 site from the Y-12 (electromagnetic), K-25 (gaseous diffusion), and S-50 (liquid thermal diffusion) areas, Du Pont had to provide the semiworks with its own machine shops, water supply and treatment installations, a steam plant, storage areas, and classrooms and laboratories for training. A number of other factors beyond the control of company officials also contributed to serious delays. The addition of installations not included in the original engineering designs and major alterations in building plans doubled the amount of construction. Furthermore, building schedules could not be maintained in the face of persistent shortages in both common and skilled labor in the region adjacent to the Tennessee site that, despite efforts, grew worse in late 1943. Unsatisfactory housing and commuting conditions aggravated these shortages by increasing absenteeism and worker turnover. Finally, there were the chronic wartime difficulties in procurement of essential building materials.[29]

The Army, endeavoring to assist Du Pont in overcoming specific bottlenecks, achieved its greatest success in expediting materials and equipment procurement. For example, when Du Pont found that its standard 5-cubic-yard trucks for hauling ready-mixed concrete were too heavy for the poor condition of the entrance road at the construction site, the Clinton area engineer obtained on short notice enough lighter trucks from the St. Louis District to do the job. Similarly, the area engineer's procurement staff arranged for the transfer of steam boilers, an item in extremely short supply, from a Du Pont plant near Nashville to the X-10 site. In another instance, when the quarry at the site failed to supply all the crushed stone needed, the area engineer secured authorization for Du Pont to pay a higher rate for material required in road construction, thus enabling the company to purchase additional amounts from sources available outside the reservation.[30]

The Army's resolution of procurement problems enabled Du Pont to meet the District's revised schedule for completion and start-up operations of the semiworks, which General Groves optimistically predicted in his October construction progress report to Maj. Gen. Wilhelm D. Styer,

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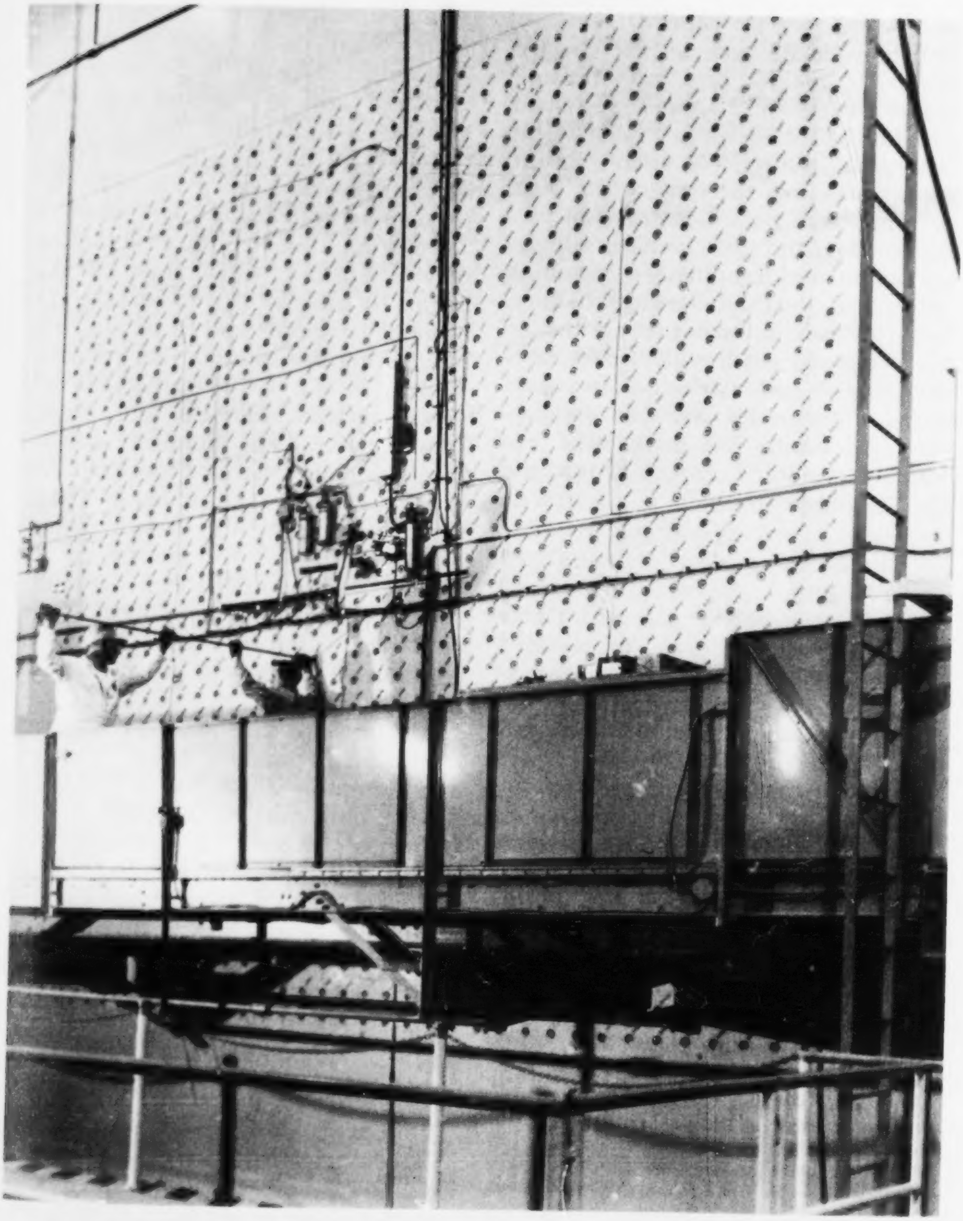
[29] Groves, *Now It Can Be Told*, p. 78; Ltrs, Read to Groves, 15 Apr 43, and Groves to Read, 22 Apr 43, Admin Files, Gen Corresp, 600.12 (Projs and Prgms), MDR; Completion Rpt, Du Pont, sub: CEW, TNX Area, 1 Apr 44, pp. 44-72, OROO. See Ch. XVII for details on measures taken to try to solve the CEW labor shortage.

[30] Completion Rpt, Du Pont, sub: CEW, TNX Area, 1 Apr 44, pp. 70-71 and 203-04.



Clinton Laboratories Pilot Pile at CEW. *Workers are inserting a uranium slug in the east loading face of the graphite pile.*

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the Army Service Forces chief of staff,[31] could be expected by mid-December. Events in the ensuing months bore out Groves's optimism. Clinton Laboratories workers began "charging" the pile in early November and, before the end of the year, were processing the first batch of irradiated slugs in the chemical separation plant and sending the resulting product to the Metallurgical Laboratory for use in further experiments. And by early 1944, only weeks later than Groves had estimated, the Manhattan commander had the satisfaction of knowing the semiworks was largely completed and well on the way to full operation.[32]

Operation

As director of the plutonium program, Compton began to develop plans for operating pile facilities at the Tennessee site as early as September 1942. He asked physicist Martin D. Whitaker, who had taken part in the early planning for a laboratory at the site, to select Metallurgical Laboratory staff members to serve as the nucleus of the X–10 operating organization. While witnessing the ongoing planning and construction of the Clinton Laboratories in the ensuing months, Whitaker and his staff made the necessary preparations for its future operation, giving a high priority to manpower recruitment.[33]

To obtain the requisite number of operating personnel to perform both industrial and managerial functions, Whitaker's staff relied heavily on the resources of the Metallurgical Project laboratories and Du Pont. The first permanent operating personnel arrived from the Metallurgical Laboratory in April, at which time Du Pont began to transfer its technicians. The number of employees increased rapidly during the months that followed, peaking in March 1944 at fifteen hundred, which included the first ten of a contingent of one hundred enlisted men from the District's newly formed Special Engineer Detachment (SED). From March until the end of January 1945, which was the period of full semiworks operation, total personnel (that is, permanent employees, trainees for Hanford, and the SED contingent) averaged about thirteen hundred.[34]

As the pilot pile attained full-scale operation in January 1944, Whitaker and Compton submitted to Major Peterson, now chief of the Clinton Laboratories Division, a projected research and development program. In it they outlined a specific schedule for plutonium production through March and, in some detail, emphasized that more than 75 percent of the laboratories' 160-man technical staff would concentrate on product isolation studies, which were essential for Hanford operations, and only 12 percent on product production. Peterson approved the program, without major changes, as the basis for semiworks operation that would contribute most effectively to the continued development of large-scale plutonium production.[35]

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[31] The Army Service Forces, formerly the Services of Supply, became the official designation with the issue of WD GO 14 on 12 March 1943.

[32] Memo, Groves to Styer, sub: Constr Progress, MD, 19 Oct 43, AG 313.3 (22 Aug 47); Dist Engr, Monthly Rpts on DSM Proj, Apr, May, Sep, Oct, Dec 43 and Feb 44, MDR; Completion Rpt, Du Pont, sub: CEW, TNX Area, 1 Apr 44, pp. 303 and 313, OROO; MDH, Bk. 4, Vol. 2, Pt. 2, pp. 4.7 and 5.3, DASA.

[33] Hewlett and Anderson, *New World*, pp. 210–12.

[34] MDH, Bk. 4, Vol. 2, Pt. 2, pp. 8.2–8.4 and App. B7 (Summary, Total Employees of Clinton Labs), DASA; Stanley L. Falk and Author, Notes on Intervs of X–10 Personnel at Oak Ridge, 22–24 Jun 60, CMH. See Ch. XVI for details on the formation of special military units, such as the SED, and on other aspects of personnel recruitment.

Soon after the pilot pile began operating, the Clinton Laboratories operating staff introduced certain design modifications with the goal of achieving greater pile productivity. Month by month, as the staff raised the efficiency of pile operation, Colonel Nichols kept General Groves informed of the increased output. By May, the pile was operating at a power level of 1,800 kilowatts, almost double that conceived by its designers, and the addition of two large fans in June and July significantly raised the level to 4,000 kilowatts.[36]

These increases would have been to no avail, however, had the separation plant failed to perform as anticipated. The operating staff remained very uncertain about the success of the chemical plant, because process designers—lacking more than minute amounts of plutonium—had not been able to make adequate laboratory tests of either the bismuth phosphate or alternate lanthanum fluoride separation method, so by early 1944 plutonium project officials were greatly relieved when the separation plant produced a small amount of relatively pure plutonium out of the first batch of slugs from the pile. In February, with the pilot pile producing irradiated uranium at a rate of one-third of a ton each day, the district engineer estimated that plutonium production for the first month of the separation plant's operation would total over 500 milligrams. During the next five months of operation, the operating staff introduced occasional modifications that eventually increased the efficiency of the separation plant from 40 to over 90 percent. The plant operated as a production unit until January 1945, when enough plutonium had been produced to meet project needs. The Clinton Laboratories then undertook experiments with other irradiated materials as fissionable fuel. At this stage the separation process was no longer required and the plant, which had processed a total of 299 batches of uranium slugs, ceased operations.[37]

In addition to testing and operating the pilot pile and separation plant, the Clinton Laboratories technical staff supplemented the Metallurgical and Argonne laboratories staffs' efforts to find solutions to the many day-to-day problems that arose directly out of the design, construction, and operation of the Hanford plants. For example, the Clinton staff had an active role in improving the canning of uranium slugs, including development of techniques to detect failure and tests to ascertain the effects of

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[35] Memo, Whitaker and Compton to Peterson, sub: Clinton Labs Prgm as of 1 Dec 43, 25 Jan 44, Admin Files, Gen Corresp, 600.12 (Projs and Prgms), MDR.

[36] MDH, Bk. 4, Vol. 2, Pt. 2, pp. 4.1 and 4.8–4.9, DASA; Dist Engr, Monthly Rpts on DSM Proj, Jan and Aug 44, MDR.

[37] Dist Engr, Monthly Rpts on DSM Proj, Jan, Mar–Jun, Oct 44 and Jan 45, MDR; MDH, Bk. 4, Vol. 2, Pt. 2, pp. 5.1–5.5, DASA; Smyth *Report*, pp. 76 and 102–04; Hewlett and Anderson, *New World*, pp. 211–12; Compton, *Atomic Quest*, p. 190. The Clinton Laboratories technical staff's recommendations for the separation process are in the Rpt CN-2021, 1 Oct 44, OROO.

water corrosion. They also studied high-neutron absorption by certain fission products produced in pile operation, a phenomenon that might cause the pile to become inoperative. But from a study of two of these products, samarium and gadolinium, they concluded that these rare elements would not lead to shutdown of the pile. They failed, however, to observe that another of the neutron-absorbing products, a radioactive isotope of the rare gaseous element xenon, was a far more potent poisoning agent. The Clinton staff used the pile, too, for testing materials to be employed in construction of the Hanford piles, including aluminum, graphite, brass, neoprene, bakelite, concrete, and masonite (for shielding).[38]

With completion of the essential aspects of the Clinton Laboratories program, which ran for more than two years (1 March 1943–30 June 1945) and cost approximately $12.3 million ($6.8 million just for salaries), the University of Chicago was anxious to be relieved of its responsibility as operator of the plutonium semiworks—a role it had accepted, but with the greatest reluctance. Acceding to the university's request, General Groves discussed with Compton the question of transferring operations of the laboratories to an industrial firm. Their choice was the Monsanto Chemical Company of St. Louis. Groves delegated to Charles A. Thomas, a company official who had been associated with the atomic project in various capacities and was currently coordinator of chemical and metallurgical work at Los Alamos, the task of carrying out negotiations. On 2 May 1945, Thomas and Groves met with other company representatives to approve an agreement under which Monsanto would take over operations of the Clinton Laboratories from the University of Chicago on 1 July. On this date, Monsanto activated a special division to handle general administration, appointing Thomas as division head, and Martin Whitaker assented to stay on as director of the laboratories, now to oversee operations for the production of experimental materials, such as radioactive isotopes, and the conduct of radiation research.[39]

The Hanford Production Plant

While Du Pont was building the semiworks, its TNX Division was moving ahead with plans and preliminary preparations for construction of the production plant. As soon as the Army acquired the site, both the TNX chief and Hanford area engineer set up field organizations that promptly began overseeing the formidable task of establishing, in the vast and remote semidesert region along the Columbia River, the support facilities essential to construction and operation of a highly complex industrial enterprise. Except for railroads and power transmission lines, these facilities were almost entirely lacking, and Du Pont and the Army had to devote many months and considerable manpower and materials to providing them before construction could begin on the plant's permanent structures.[40]

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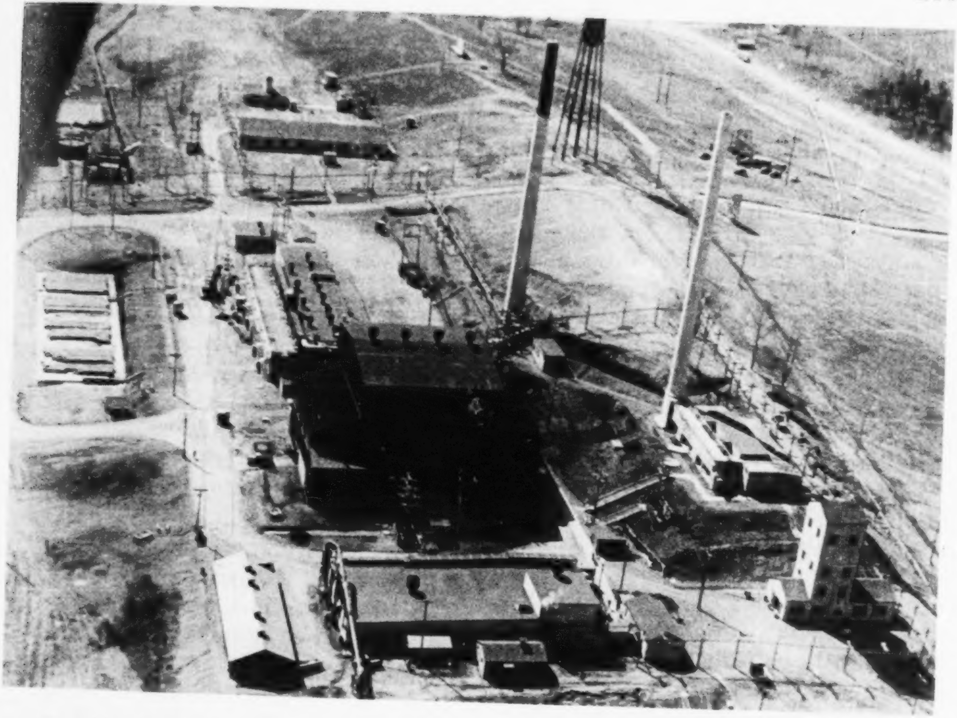
[38] MDH, Bk. 4, Vol. 2, Pt. 1, pp. 6.2–6.8, DASA.

[39] Ibid., Pt. 2, pp. 3.5–3.6, DASA; Groves Diary, 23–25 Apr and 2 May 45, LRG; Compton, *Atomic Quest*, p. 197; Hewlett and Anderson, *New World*, p. 627.

[40] Paragraphs on preliminary measures that Du

Continued



Clinton Laboratories, *consisting of the large pilot pile building, the chemical separation plant (structure directly to the rear), and other support facilities*

Consequently, during much of 1943, Du Pont and its subcontractors extended and improved existing roads and railroads, power and telephone lines and sewer and water systems. They built temporary facilities that, because of the remoteness of the site and also the safety and security requirements, had to be unusually extensive, including the Hanford camp for construction workers, numerous buildings to house Du Pont and Army administrative personnel in the field, and a variety of shops. Thus, at White Bluffs, adjacent to the site selected for the plutonium separation plants, they built shops to fabricate concrete pipes, masonite panels, and steel plate sections; at Hanford, near the construction camp, erected a shop to shape, cut, bore, face, and test graphite; and at strategic points in the plant construction area, installed five concrete plants. In addition, they provided repair and maintenance

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Pont and the Army had to carry out in preparation for construction of the Hanford plutonium plant based on MDH, Bk. 4, Vol. 5, Secs. 1–5, DASA; Du Pont Constr Hist, Vols. 1–2, HOO; Matthias Diary, 1943, passim, OROO; Memo, Travis to Marsden (Ex Off, MD), sub: Status of HEW as of 2 Jun 43, same date, in Rpt, sub: MD Proj Data as of 1 Jun 43, MDR. See Chs. XIII–XIV and XVI for detailed account of measures taken to solve the problems in materials and manpower procurement for Hanford.

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shops, including those for railroad, automotive, electrical, and construction equipment.

Du Pont and the Army also were able to begin some work that related directly to the construction of the production plant. For example, the Army's Seattle district engineer supervised soil tests and borings at the sites selected for the permanent plant facilities. These tests and soil samples provided Du Pont field engineers with essential data on the weight-carrying capacities of the ground, especially significant because many of the plant installations were enormously heavy; on rock formations likely to cause difficulties in excavation work; and on the availability of aggregate for making concrete. Field survey teams inspected existing transmission lines and road nets in the plant areas, reaching the conclusion that these facilities were adequate to meet the requirements for the earliest phases of plant construction. The area engineer and Du Pont were able to agree on optimum locations for most of the major plant installations, taking into account also safety, security, transportation, availability of river water, and other related factors.[41]

Construction

Decisions on the character and location of various plant installations deviated surprisingly little from the general layout of the production plant developed back in mid-December 1942 to serve as a guide in site selection. These early plans had projected initial construction of at least three pile and two separation units, with provision made for the addition, if need be, of three more piles and another separation unit. In the main, such changes as the Du Pont design team did make reflected the subsequent decisions to employ water cooling rather than helium for the graphite piles and a bismuth phosphate precipitation method in the separation units.[42]

The specific layouts provided for seven separate process areas, six of them located generally in the northern half of the 400,000-acre Hanford reservation and the seventh in a sector directly north of the operating village of Richland in the southeastern corner of the reservation (*Map 4*). The three production piles were located at the points of a triangle formed by a bend in the Columbia River near White Bluffs. Designated as the 100 B (West), 100 D (North), and 100 F (East) Pile Areas, each was about 1 mile square and, for reasons of safety, about 6 miles distant from any neighboring installation. About 10 miles directly south of the pile sites were the three separation process areas: 200 W (West), 200 E (East), 200 N (North). In the West Area there were two separation plants, with a mile of open desert between them; in the East Area, only a single separation plant; and in the North Area,

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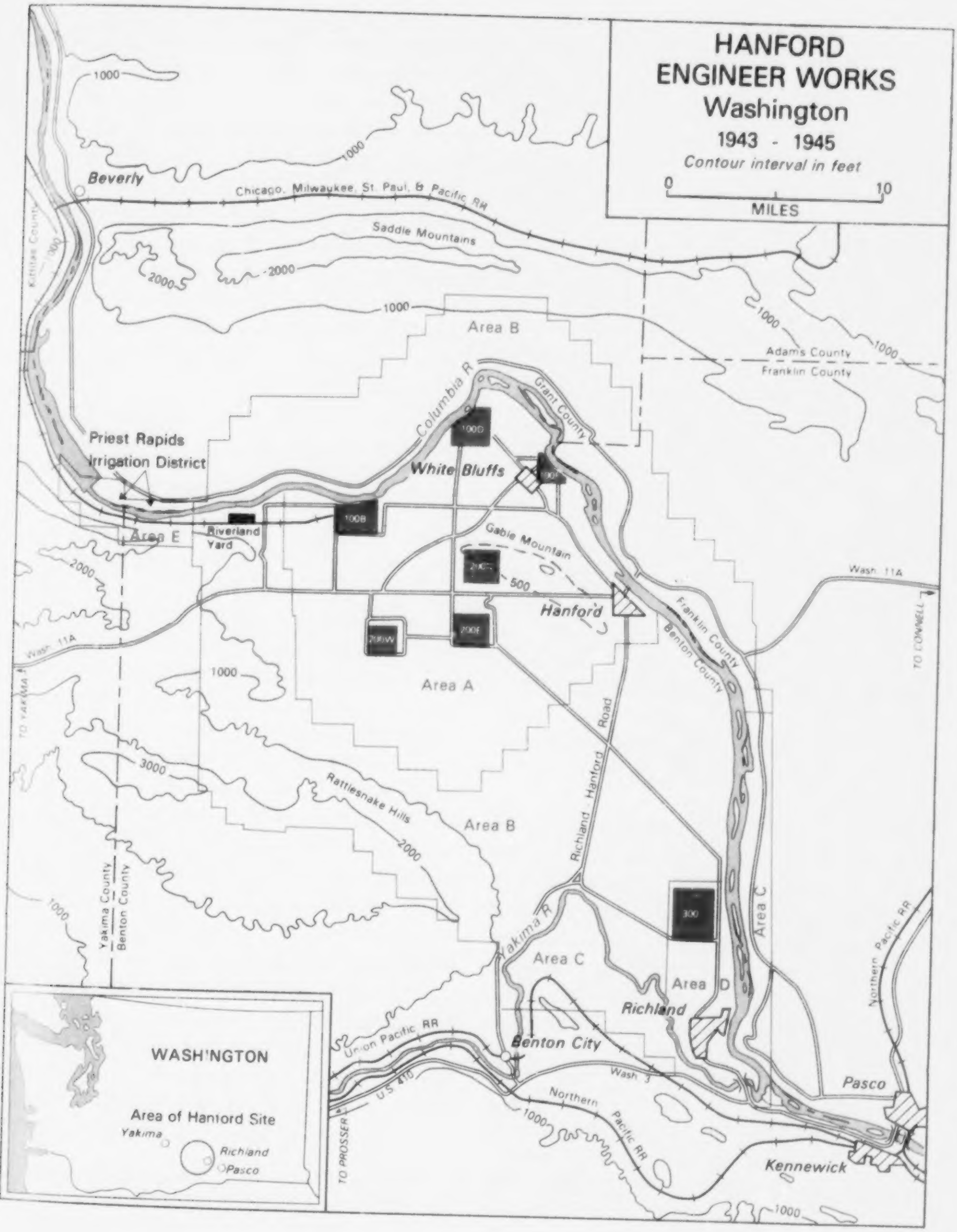
[41] MDH, Bk. 4, Vol. 5, pp. 2.1–2.7, DASA; Matthias Diary, 24 Feb 43, OROO. See Chs. XVIII and XIX for more details on development of process support facilities for the production plant.

[42] This paragraph and the several that follow based on DSM Chronology, 14 Dec 42, Sec. 25, OROO; MDH, Bk. 4, Vol. 3, pp. 2.1–2.2., 3.1–3.7, Apps. A2 and A4 (Maps, Location of Major Instls), and Vol. 6, pp. 2.1–2.5, DASA; Du Pont Constr Hist, Vols. 3–4, HOO; Hewlett and Anderson, *New World*, pp. 214–22 and map opposite p. 225. See Ch XV for general layout of the plant in relation to site acquisition.


HANFORD
ENGINEER WORKS
Washington
1943 - 1945
Contour interval in feet
0
10
MILES
Beverly
Chicago, Milwaukee, St. Paul, & Pacific RR
Saddle Mountains
Kittitas County
Grant County
Adams County
Franklin County
Benton County
Yakima County
Columbia R.
Yakima R.
Area A
Area B
Area C
Area D
Area E
Priest Rapids
Irrigation District
Riverland
Yard
White Bluffs
Gable Mountain
Hanford
Richland - Hanford Road
Rattlesnake Hills
100D
100B
100F
200E
200W
300
Wash. 11A
TO YAKIMA
TO CONNELL
TO PROSSER
Richland
Benton City
Pasco
Kennewick
Union Pacific RR
Northern Pacific RR
U.S. 410
Wash. 3
1000
2000
3000
500
WASHINGTON
Area of Hanford Site
Yakima
Richland
Pasco

MAP 4

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only the lag-storage facilities for holding the pile-processed uranium metal until natural decay reduced its radioactivity to a point where it could be sent to the separation plants. In the seventh process site—the 300 Area—were the metal testing and fabricating facilities for preparing uranium to be charged into the piles.

In scheduling construction of the various permanent installations, Du Pont gave priority to the 300 Area, for it included many installations that were essential both to building and operating the rest of the plant. Here, for example, were facilities for testing many of the building materials to be incorporated into the piles and separation units, for preparing uranium metal to be charged into the piles, and for assembly and calibration of instruments to control production operations and protect workers against radiation. One of the buildings housed an operating test pile. Another held the machines that "canned" uranium in metal containers to be inserted for processing in the piles.

In spite of the high priority, however, Du Pont experienced great difficulty in meeting building schedules in the 300 Area. Stabilizing designs was the most frequent cause of delay, attributable primarily to the lack of previous experience. Related to the design problem was the frankly experimental character of many of the facilities. Other factors slowing construction were the shortage of skilled labor and the classified nature of much of the work, requiring restriction of access to the 300 Area. Yet construction crews pressed forward during the summer and fall of 1943, turning to the area engineer for assistance. Through Army intervention with wartime labor officials, the company secured permission for double work shifts of nine hours on urgently required buildings. It also obtained special handling in procurement of certain materials. It let subcontracts, which the area engineer approved, to firms with specially qualified personnel and equipment and speeded up procedures for approval and issue of designs. These various expedients, however, were never quite sufficient to overcome the bottlenecks, and work in the 300 Area remained consistently behind schedule.[43]

In the three pile areas and the 300 Area, Du Pont faced the problem of erecting a great variety of facilities. Each pile area comprised an industrial complex made up not only of a production unit but also of support elements. The latter included equipment for pumping vast amounts of water from the nearby river and subjecting it to treatment to make it suitable for cooling the piles. It also included refrigeration and helium-purification units and extensive storage facilities. Each area, too, had its own facility to provide steam and some electricity. Most of the support elements had to be housed in large industrial-type buildings, some of them with tall stacks and water storage tanks on high steel-frame towers.

For the experienced Du Pont engineers and foremen, much of the work was sufficiently conventional to present no serious problems other

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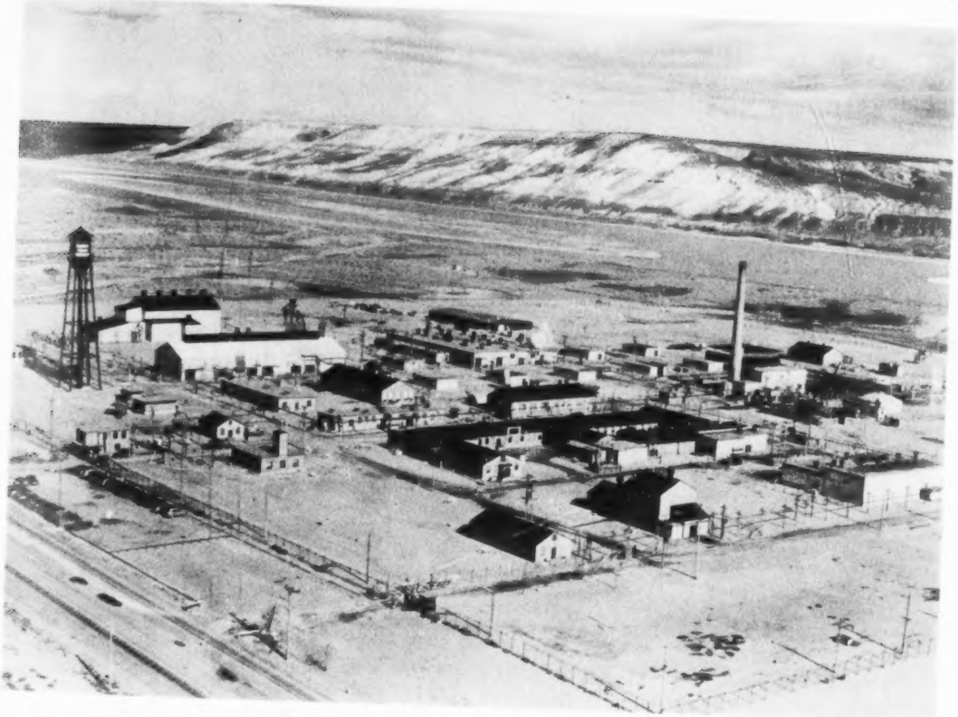
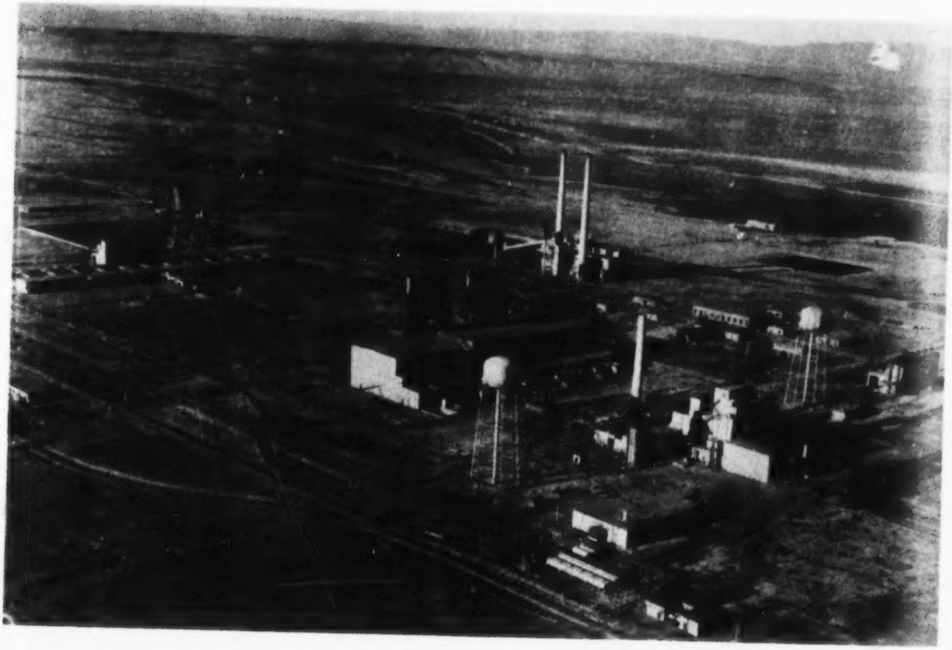
[43] Dist Engr, Monthly Rpts on DSM Proj, Nov–Dec 43 and Dec 44, MDR; MDH, Bk. 4, Vol. 5, pp. 6.1–6.4 and Apps. B35–B37 (Tables and Charts, Constr Progress and Subcontracts for Metal Fab and Test Area), DASA.



THE 300 AREA AT HEW, *where Du Pont workers manufactured uranium slugs and tested materials for the piles. The slogan on the water tower reads, "Silence Means Security."*

than those attributable to geographic isolation and wartime conditions. The exception was the production piles. Housed in concrete structures rising more than 120 feet from the flat desert floor, these great machines for transmuting uranium into plutonium presented construction problems never encountered before, even by Du Pont's highly competent field forces. As in the 300 Area, but on a far vaster scale, the construction crews not only had to cope with almost day-to-day changes in design and specifications but also to adopt many expedients based upon results of tests, construction experience, and limitations of materials.

Using water as a coolant required installation of a complex system of river pumps; purification, aeration, and distillation units; and retention basins for holding radioactive water until natural decay permitted its return to the Columbia. Because keeping the piles at a proper temperature was crucial, plant designers included a refrigeration unit in both the North (100 D) and East (100 F) Areas as a precautionary measure to cool river water during the summer months; however, to save time, they



THE 100 B PILE AREA AT HEW, *consisting of the production pile (building with single stack), the steam-electric plant (building with twin stacks), the pump house (on the Columbia River), and other support facilities*

did not provide this unit in the West (100 B) Area, gambling on the chance it might not be necessary.[44]

Completion of at least one pile and a separation unit would start production of urgently needed plutonium. Accordingly, Du Pont and Army officials agreed to give the West Pile Area priority, concentrating the limited materials and manpower available to expediting its construction. Late in 1943, they scheduled the West Pile for operation by June 1944, but by February, with the plant only 27 percent complete, they rescheduled the start-up date to mid-August. At the same time, they established later completion dates for the North and the East Pile Areas.

The pace of construction, however, was disappointing. In general, the factors that slowed construction in the 300 Area also adversely affected the pile areas—the isolated location of the Hanford reservation, aggravating shortages of manpower and essential materials, the uniqueness of much of the construction, and the continuing need for alterations in orginial designs and specifications.

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[44] Paragraphs on construction of production piles based on MDH, Bk. 4, Vol. 5, pp. 3.2–3.5, 6.5–6.22, Apps. B38–B42, and Vol. 6, pp. 2.5–2.18, DASA; Du Pont Constr Hist, Vol. 3, pp. 636–811, HOO; Hewlett and Anderson, *New World*, pp. 216–18; Dist Engr, Monthly Rpts on DSM Proj, Jan–Mar 44, MDR.

As in the 300 Area, the Army gave its approval to Du Pont's various expedients to speed up construction. The company instituted shift work in September 1943, at the same time extending the regular work week to six nine-hour days (in some cases, manual labor temporarily put in ten hours a day, seven days of the week). It let more than thirty subcontracts to firms that would carry out specialized aspects of the job—for example, boiler and elevated tank erection, pipe work, concrete block and cement brick construction, channel excavation—and thus gained access to desperately needed manpower and equipment. And Du Pont repeatedly turned to District procurement personnel in Hanford, Oak Ridge, and Washington, D.C., for assistance in obtaining a great variety of scarce materials and equipment, including such items as solenoid valves, synthetic cable, and stainless steel fittings and valves. The Army also expedited shipment of many crucial items from suppliers distant from the isolated site, authorizing use of air and rail express, trucks, and even the Army Air Forces' Air Transport Command planes. The Army, too, allowed Du Pont's TNX Division to ease the persistent design bottlenecks by sending out special personnel to work in the division engineer's office at the West Pile site, authorizing them to make on-the-spot minor alterations without clearing them with the home office.

By spring of 1944, these expedients and a gradual easing of manpower problems brought a decided improvement in the progress of pile area construction. The district engineer estimated that the West Pile Area was nearly half completed, and in September he pronounced it ready to go into operation. Du Pont construction crews failed to meet the scheduled October completion date for the North Pile, requiring an additional two months. Then, with the advantage of experience and a far more adequate supply of labor, they managed to finish the East Pile Area on 10 February, five days earlier than the projected completion date. Weeks earlier, the West Pile had discharged its first batch of "active metal," and plant workers immediately sent it to the West Separation Area for processing.[45]

In building the chemical separation facilities, Du Pont crews encountered many of the same problems they faced in construction of the production piles; however, for the most part, the problems were never quite as severe. There was more time to build the separation units, as no irradiated slugs would be ready for processing until weeks or months after the first pile began to operate, and there were fewer installations to build, with a total of thirty-two process buildings in the three separation areas (200 E, W, and N) as compared with fifty-three in the three pile areas. Also, there was less need for changes in specified design, construction materials, and equipment.[46]

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[45] See MDH, Bk. 4, Vol. 5, Apps. B41 (List, Subcontractors for Pile Area Constr) and B42 (List, Materials Used), DASA; Dist Engr, Monthly Rpts on DSM Proj, Apr, Jun, Nov, Dec 44 and Feb 45, MDR.

[46] Paragraphs on construction of plutonium separation units based on MDH, Bk. 4, Vol. 5, pp. 3.5–3.7, 6.22–6.31, Apps. B43–B46, and Vol. 6, pp. 2.18–2.26, DASA; Du Pont Constr Hist, Vol. 3, pp. 812–983, HOO; Hewlett and Anderson, *New World*, pp. 219–22; Dist Engr, Monthly Rpt on the DSM Proj, Jan 44, MDR.

Design problems were a significant factor in delaying the construction of the separation plants. Du Pont design teams could do little toward providing detailed blueprints and specifications until project scientists and engineers reached a decision on the exact chemical process to be employed. Even after the decision to use the bismuth phosphate method, designers had to await additional data from the Clinton separation plant, still under construction. Consequently, in 1943, Du Pont had accomplished little beyond site preparation and excavation in the separation plant areas.

Detailed blueprints and specifications, finally ready by early 1944, projected construction of four separation plants—two in the East Area and two in the West Area (in June, project officials canceled one East Area unit when performance data at the Clinton separation plant indicated it probably would not be needed). Completed layouts provided for a variety of process buildings and supporting facilities. The dominant feature of each plant area was a "cell building," an enlargement of the six-cell unit in the Clinton plant. Viewed from a distrance across the level desert, this massive (800 feet long, 65 feet wide, and 80 feet high) concrete structure resembled an ancient mausoleum. A railroad system interconnected the various facilities and provided the means for transporting the thick-walled portable casks that brought irradiated slugs from the pile areas for temporary storage in the North Area and final processing in the East or West Separation Areas.

Insufficient manpower proved a major problem never fully solved, but partially alleviated by Army-sanctioned reallocation of workers from other parts of the project, very frequent use of shift and Sunday work, and extended hours. Materials shortages, most notably of stainless steel, resulted in serious delays. With District assistance, Du Pont saved three to four months in obtaining stainless steel for more then 700,000 feet of piping; 150,000 bolts; and other equipment. The company saved time, too, by subcontracting (with approval of the area engineer) work on structural steel, railroads, pipe and tank installation, and other aspects of construction.

The disappointing progress in construction reported by the district engineer at the end of December 1943 clearly indicated that his earlier projections had been far too optimistic. Thus in February 1944, Du Pont issued new start-up dates for various elements of the pile and separation areas, which became the basis for subsequent building schedules. Although plagued by continuing delays in delivery of stainless steel, Du Pont completed the two West Area separation plants and the North Area lag-storage facilities in December, in time to accept the first irradiated slugs from the West Pile. Finally, in early February 1945, with the East Separation Area ready to be turned over to operating crews, Colonel Nichols reported to General Groves that the Hanford Engineer Works was substantially completed.[47]

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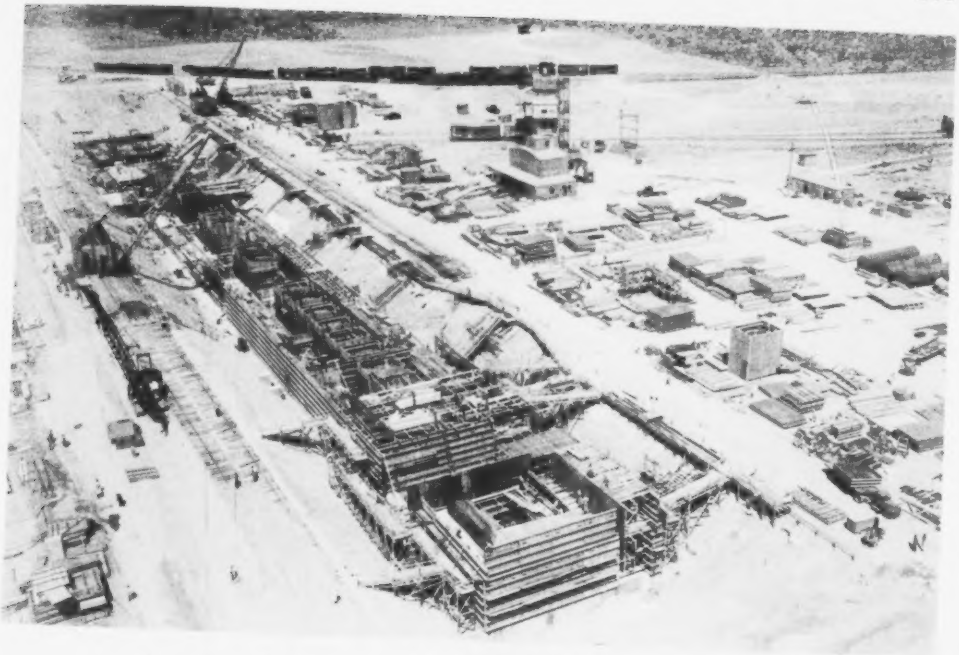
[47] Dist Engr, Monthly Rpts on DSM Proj, Jan, Apr, Jun, Dec 44 and Jan 45, MDR.



CHEMICAL SEPARATION PLANT UNDER CONSTRUCTION AT HEW

Operation

Although construction crews were months away from completing all of the major elements of the plant, Du Pont operating crews took the first step in starting plant operations when they began charging the West Pile with aluminum-covered uranium slugs on 13 September 1944.[48] As with the electromagnetic and diffusion plants at the Clinton Engineer Works, production of plutonium at Hanford was a highly technical operation, carried out, for the most part, by an operating force comprised of Du Pont engineers, technicians, and trained plant personnel. The Army had only a limited role in plant operations, its primary function being to maintain those conditions in the plant areas and Richland village community that would enhance in every way possible production of plutonium. To this end, the Hanford Area Engineers Office continued to provide most of the services instituted in the period of site development and plant construction, including security, safety, transportation and communications, personnel and materials procurement, fiscal and contract review, and community support.

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[48] Except as indicated, subsection on production plant operation based primarily on MDH, Bk. 4, Vol. 6, DASA; Du Pont Opns Hist, HOO; Matthias Diary, Sep 44–Aug 45, OROO; Hewlett and Anderson, *New World*, pp. 304–10. The Army's activities in providing essential services are described in subsequent chapters, especially XVI–XX.

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COMPLETED CHEMICAL SEPARATION PLANTS *(foreground and background), serviced by the twin-stacked steam-electric facility*

In mid-August, Du Pont operating personnel began taking over the West Pile building, although construction crews continued to work in the area. On the seventeenth, Colonel Matthias notified Colonel Nichols at Oak Ridge that he thought "anytime after the 27th of August would be a good time to come out for the initial starting operations." Both Nichols and Groves found reasons for visiting: ostensibly, as project officials, to confer on labor and safety problems; tacitly, as engineers, undoubtedly drawn by the natural desire to see near completion a project to which they both had devoted many months of effort. Groves arrived on 1 September and Nichols on the following day. Matthias took each on a personal inspection tour. Both gave special attention to the crucial preparation of the uranium fuel. They were pleased to learn that a welding process had largely eliminated leaks in the cans, or slugs that held the uranium fuel, a problem that for many months had posed a threat to the whole process.[49]

Neither Groves nor Nichols could be present on 13 September, when the plant workers started up the West

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[49] Matthias Diary, 1–2 Sep 44 and 17 Aug 45 (source of quotation), OROO; Groves Diary, 1 Sep 44, LRG. On uranium canning problem see MDH, Bk. 4, Vol. 6, pp. 4.7–4.9 and 5.7–5.8, DASA; Hewlett and Anderson, *New World*, pp. 223–26 and 303–04.

Area production pile for the first time. But Colonel Matthias was on hand, as were Compton and Fermi from the Metallurgical Project and Greenewalt and Williams from Du Pont. In a scene somewhat reminiscent of that dramatic occasion when Fermi had achieved the first controlled chain reaction, the redoubtable Italian physicist inserted the initial uranium fuel can into the production pile at 5:43 P.M. Thus began the slow procedure, interrputed by many tests that would bring the pile, on the fifteenth, to that level of reactivity known as dry critical. At this stage, without cooling water present in the fuel tubes, the pile contained enough uranium to sustain a chain reaction. Up to this point the pile was performing precisely as anticipated.[50]

For the next few days the loading crews, under Fermi's guidance, inserted additional slugs, building up to the number he estimated would be required for the pile to be reactive with cooling water in the tubes. They reached this number—actually 838 tubes loaded—late in the afternoon of 18 September and began final tests of the cooling system. These tests and other measurements continued for several days, until shortly before midnight on the twenty-sixth. At 10:48 P.M., with more than 900 of the 2,004 tubes loaded, they started withdrawl of the control rods to begin for the first time plutonium manufacture on a production scale. But to their surprise, when they tried to increase the power level, the level of reactivity began to decline and, by 6:30 P.M. on the twenty-seventh, the pile shut down completely. Colonel Matthias immediately informed General Groves, who was visiting the Radiation Laboratory in Berkeley. Arriving in San Francisco on the thirtieth, Matthias explained to Groves that the pile operators at first believed that water, or some other neutron-absorbing substance, had leaked into the pile. Yet when they found no evidence of this, they concluded that unanticipated buildup of a fission byproduct had inhibited reactivity of the pile. Matthias suggested to Groves "that certain of the high-ranking scientists come out to Hanford immediately to supervise corrective action."[51]

Meanwhile at Hanford, Greenewalt had turned to the Metallurgical Project scientists for an explanation. Nothing in the Clinton operations seemed to provide an answer, but the Argonne staff discovered that when they ran the heavy water pile at its highest power level for a period of twelve hours (which they had not previously done), its reactivity first rose and then declined following a pattern similar to that observed at Hanford. The data from the Argonne pile also confirmed that the "poisoning" of the pile was caused by one of the fission by-products, a radioactive isotope of the rare gaseous element xenon. At a meeting with Compton and Metallurgical Project scientists in Chicago on

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[50] Matthias Diary, 13–14 Sep 44, OROO; Rpt, Matthias to Dist Engr, sub: Monthly Opns, 30 Sep 44, Admin Files, Gen Corresp, 319.1 (Misc), MDR; Du Pont Opns Hist, Intro, p. 22, and Bk. 4, HOO.

[51] Quotation from Matthias Diary, 30 Sep 44 OROO. See also ibid., 16–17, 19–21, 25–29 Sep 44, OROO; Groves Diary, 29–30 Sep 44, LRG; Dist Engr, Monthly Rpt on DSM Proj, Sep 44, MDR; Memo, Matthias to Groves, sub: Status of 100 B Area Opns, 18 Sep 44, Admin Files, Gen Corresp, 319.1 (Misc), MDR; MDH, Bk. 4, Vol. 6, pp. 4.9–4.10 and App. D1 (Xenon Poisoning), DASA.

3 October, Groves was highly critical of the scientists for not having discovered a phenomenon that might well prevent production of sufficient plutonium in time to be used in the war. Sensing the gravity of Groves's words, Compton left immediately for Hanford so that he could take direct action.[52]

By the time Compton reached Hanford on the fourth, operating personnel working under Greenewalt, Hilberry and others had found that by adding more uranium slugs to the pile charge they could increase the power level without inducing a decline in reactivity. This demonstrated that pile operation at a higher power level overcame the dampening effects of xenon poisoning, but it still did not tell the pile operators how much more uranium they would have to load into the pile to raise the power level to that point where it would efficiently produce plutonium. Nor did it indicate whether the existing controls and instrumentation of the pile were adequate for such operation.

For answers to these critical questions they had to carry out a time-consuming series of tests. They gradually increased the uranium load, carefully checking and adjusting the complicated control devices and instruments of the pile. By late November, they showed conclusively that by fully loading the pile, including slugs in the extra tubes that Du Pont's conservative designers had installed against the advice of the scientists, the pile would operate at its designed power level. As a final precaution, the operating personnel tried operating the 100 D pile (completed in November) with uranium in all tubes, but without cooling water. The success of this dry critical test clearly demonstrated that the 100 B pile, with the added protection of cooling water, was likely to function as designed. On 28 December, the 100 B pile, with all its 2,004 tubes loaded went into operation, marking at last the start of full-scale production of plutonium.[53]

Xenon poisoning and uranium canning problems were not the only technical difficulties faced by Du Pont's operating personnel as they took over control of the other units of the plutonium production plant. But none of the other start-up problems posed so serious a threat to the effective operation of the plant, and Du Pont engineers found solutions adequate to eliminate or counteract their adverse effects upon the plutonium production process.[54]

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[52] Memo, Compton to Groves, sub: Oscillation Effect of W Pile, 30 Oct 44, Admin Files, Gen Corresp, 400.12 (Experiments), MDR; Memos, Walter Zinn (Argonne Lab scientist) to Compton, 3 Oct 44, Compton to Groves, sub: Draft Notes to Mtg at Chicago, 3 Oct 44, and Matthias to Groves, sub: Start-up Opns of 100 B Area, 3 Oct 44, Admin Files, Gen Corresp, 319.1 (Misc), MDR; *Oppenheimer Hearing*, p. 174; MDH, Bk. 4, Vol. 2, Pt. 1, pp. 3.13–3.14 and 5.2–5.3, and Pt. 2, pp. 6.4–6.5, DASA; Hewlett and Anderson, *New World*, pp. 306–07; Dale F. Babcock, "The Discovery of Xenon-135 as a Reactor Poison," *Nuclear News* 7 (Sep 64): 38–42.

[53] Dist Engr, Monthly Rpts on DSM Proj, Nov–Dec 44, MDR; Memo, Compton to Mrs. O'Leary, Attn: Groves, 7 Oct 44, Admin Files, Gen Corresp, 400.17 (Mfg-Prod-Fab), MDR; Groves, Notes on Conf with Greenewalt in New York, 18 Oct 44, Admin Files, Gen Corresp, 337 (Confs), MDR; Memos, Matthias to Groves, sub: Start-up Opns of 100 B Area, 17 and 20 Oct 44, Admin Files, Gen Corresp, 319.1 (Misc), MDR; Matthias Diary, Oct–Dec 44, passim, OROO; MDH, Bk. 4, Vol. 6, pp. 4.10–4.12 and App. D1, DASA; Compton, *Atomic Quest*, pp. 191–94; Hewlett and Anderson, *New World*, pp. 307–08.

[54] For a more detailed account of some of the other operating problems that developed in Hanford pile operations see MDH, Bk. 4, Vol. 6, pp. 4.12–4.19, DASA.

With attainment in March 1945 of full-scale production at Hanford, the plutonium project leaders turned with renewed energy to establishing firm production schedules and to reaching agreement on final specifications for the product. General Groves, aware that the war in Europe was rapidly approaching an end and knowing that the scientists at Los Alamos would soon need substantial quantities of plutonium, arranged with Du Pont to run the two refrigerated production piles above their rated operational level during the spring and summer of 1945. Carried out at some risk, this procedure substantially increased product output and thus provided the plutonium for an atomic device in July and for one of two bombs in August. Through these events, vindication finally came to the atomic project leaders on their late-1942 decision to go ahead with the development of the pile process—a decision that, in the intervening years, when the plutonium program experienced repeated setbacks, may well have appeared to many to have been a serious error in judgment.[55]

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[55] The correspondence concerning speeding up plutonium production at Hanford is in two separate MDR files. In Admin Files, Gen Corresp, 400.17 (Mfg-Prod-Fab): Ltrs, Groves to Williams, 13 Jan 45, and Williams to Groves, 16 Jan 45. In OCG Files, Gen Corresp, Groves Files, Fldr 5: Ltrs, Williams to Groves, 14 Feb 45, and Groves to Williams, 15 Feb 45, both Tab I; Memo, Nichols to Groves, sub: Site W Prod Schedule, 9 Mar 45, Tab J; Ltr, Groves to Oppenheimer, 22 Mar 45, Tab L; Ltr, Groves to Williams, 22 Mar 45, Tab J; Ltr, Williams to Groves, 9 Apr 45, Tab M; Memo, Groves to Nichols, 20 Jul 45, Tab S. See Ch. XXIV on the relationship between the development of the implosion bomb at Los Alamos and the rate of plutonium production at Hanford.

PART THREE

SUPPORT ACTIVITIES

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CHAPTER X

Anglo-American Collaboration

On 15 December 1942, the Military Policy Committee submitted its first report to the Top Policy Group on the "present status and future program" of the Manhattan Project. The report dealt at length with such matters as scientific progress, the organization of the project, the need for funds, the availability of raw materials, and the status of the Anglo-American atomic partnership. The latter, reported the committee in something of an understatement, needed "clarification." [1] In effect, at the urging of OSRD Director Vannevar Bush, S-1 Chairman James B. Conant, and General Groves, the Military Policy Committee was proposing a reconsideration of American policy on the exchange of information and a presidential decision not only on the immediate problem but also on the far-reaching one of postwar relations in the field of atomic energy.[2]

This call to reevaluate Anglo-American collaboration on atomic energy research and development was a result of the extensive and rapid expansion of the Manhattan Project during the past six months. Until then the American effort had faced serious problems and its leaders had been willing, even eager, to compare notes with their British counterparts. But, by the fall, with both the scientific and engineering programs moving ahead, the project's military and civilian administrators had made an impressive start at cutting away red tape, thus assuring the atomic program a strong and solidly backed position in the American war effort. As the need for British assistance seemed less urgent, a new attitude about interchange took hold, and in December project leaders voiced their increasing reluctance, reinforced by growing security considerations, to give the British the fruits of American labors.

Breakdown of Interchange

The atomic partnership between the United States and Great Britain, which the allies had begun on a small scale in the fall of 1940 and developed into a full exchange program by late 1941, first underwent a slight modification in the early summer of 1942. Meeting at Hyde

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[1] MPC Rpt, 15 Dec 42, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab B, MDR.

[2] Memo, Stimson, 29 Oct 42, HB Files, Fldr 47, MDR; MPC Rpt, 15 Dec 42, MDR. This theme is developed at length in Hewlett and Anderson, *New World*, pp. 256-67.

Park on 20 June, President Franklin D. Roosevelt and Prime Minister Winston S. Churchill agreed that the United States should take the major role in atomic weapons production and that Great Britain should devote its already severely limited resources to the more immediate problems of fighting the war. In spite of this somewhat qualified yet carefully considered arrangement, which would permit the British to avoid the risk that large-scale atomic installations might be damaged or destroyed by German air raids, Churchill left the conference with the "understanding . . . that everything was [still] on the basis of fully sharing the results as equal partners," and shortly thereafter Roosevelt reported to Bush that he and Churchill were "in complete accord." [3]

It appeared that the two wartime leaders had reaffirmed continuation of the free and open exchange of atomic information; however, developments in the months following the Hyde Park summit clearly illustrate the slow waning of Anglo-American collaboration. On 5 August, six weeks after the Roosevelt-Churchill talks, the British Cabinet officer in charge of atomic energy, Sir John Anderson, Lord President of the Council—who was to the Tube Alloys program what Secretary Stimson was to the DSM program—wrote to Bush. He proposed integrating the British gaseous diffusion project into the American program and, as a consequence, providing British representation for the OSRD S–1 Executive Committee.[4] Thus, with the simultaneous transfer of the British heavy water research group to Canada, which Sir John concurrently was suggesting to Canadian authorities, most Tube Alloys activities would be removed beyond the danger of German air attacks. Sir John also made reference to the broader question of controlling atomic energy, both during the war and afterwards. For this, he recommended immediate implementation of a joint policy on patents and raw materials and the early establishment of an Anglo-American commission on atomic energy.

Anderson's proposals reached Bush at a time when the Manhattan Project still was beset with major difficulties; scientific problems loomed large, adequate priorities were lacking, no decision had been reached on site questions, and even the basic matter of organization remained unresolved. Bush, accordingly, was in no position to commit himself to anything far-reaching, no matter how much he still desired British assistance. Finally on 1 September, after checking with Stimson's assistant, Harvey Bundy, Bush replied to Anderson, expressing general approval of close Anglo-American collaboration but putting off for the moment any specific implementation of this principle. Only the transfer of the heavy water group to Canada—an action subsequently taken—elicited his immediate concurrence. For the rest, he said, he would reply "somewhat later when other broad phases have been resolved."[5]

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[3] Quotations from Msg, Prime Minister to Harry L. Hopkins, 27 Feb 43, HLH, and Memo, Roosevelt to Bush, 11 Jul 42, FDR. See also Ltr, Bush to Styer, 19 Jun 42, HB Files, Fldr 6, MDR; Ltr, Bush to President, 19 Jun 42, FDR; Winston S. Churchill, *The Second World War: The Hinge of Fate* (Boston: Houghton Mifflin Co., 1950), pp. 374–81.

[4] The terms *Tube Alloys* and *DSM* (Development of Substitute Materials) were the official code names for the British and American atomic energy projects in WW II. See Ltrs, Anderson to Bush, 5 Aug 42, HB Files, Fldr 47, MDR; Gowing, *Britain and Atomic Energy*, pp. 188–89; George C. Laurence, "Canada's Participation in Atomic Energy Development," *Bulletin of the Atomic Scientists* 3 (Nov 47): 326.

Within the next few weeks, Manhattan leaders were successful in overcoming many of the uncertainties. Yet a strong desire for the kind of close partnership Anderson had suggested still was lacking; indeed, when General Groves raised the question of Anglo-American relations at the S-1 Committee meeting in Stimson's office on 23 September, no one pressed for immediate action. Because some members felt working closely with the British might even slow down American research, the committee agreed to delay any decision until Stimson had talked with the President. When Bush wrote to Anderson a week later, he outlined the new American organization and urged continued close contact, but he purposely avoided a precise commitment, pending word from the President.[6]

It was the end of October before Stimson was able to discuss the issue with Roosevelt, for this was a period when relations between the Secretary of War and the President were somewhat strained by disagreement over the forthcoming North African operations and Stimson saw Roosevelt infrequently. Finally, following a Cabinet meeting on the twenty-ninth, he seized the opportunity to talk with Roosevelt alone. After pointing out that the United States was doing most of the work on atomic energy, the Secretary added that Manhattan leaders wanted to learn what commitments the President had made to the British. When the President assured him his conversation with Churchill had been "of a very general nature," Stimson suggested going "along for the present without sharing anything more than we could help." The President agreed but indicated that he, Churchill, and Stimson had better talk over the whole problem before too long. And there the matter rested.[7]

Meanwhile, as the American Army took over management of more aspects of the atomic project, the British were becoming disturbed at the trend toward an independent course that minimized Anglo-American cooperation. Hence, no one was surprised when Anderson proposed that Wallace A. Akers, the engineer who headed the British Directorate of Tube Alloys (which was comparable to Conant's position as chairman of the S-1 Executive Committee) should visit Washington, D.C. During the weeks that followed Akers' arrival in early November, he assiduously consulted with Bush, Conant, and Groves, seeking ways to link more closely the American-British atomic energy programs but achieving only an agreement on steps to set up and support the British heavy water research group in Canada.

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[5] Ltr, Bush to Anderson, 1 Sep 42, OCG Files, Gen Corresp, MP Files, Fldr 16, Tab A, MDR. See also Memo, Bush to Bundy, 1 Sep 42, HB Files, Fldr 47, MDR.

[6] Rpt, Bundy, sub: S-1 Mtg at Secy War's Office, 23 Sep 42, HB Files, Fldr 6, MDR; Groves, *Now It Can Be Told*, p. 128; Ltr, Bush to Anderson, 1 Oct 42, HB Files, Fldr 47, MDR; Ltr, Bush to Bundy, 1 Oct 42, HB Files, Fldr 7, MDR.

[7] Memo, Stimson, 29 Oct 42, MDR. See Stimson Diary, HLS, for the state of Stimson's relations with the President during this period.

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What Akers wanted, based on his understanding of agreements reached "at the highest levels," was a "really cooperative effort between the two countries." [8] This would include joint research, development, and production efforts, and complete interchange of information on all aspects. British scientists and engineers would work in American plants and their American counterparts would do the same in England. Each country would make available to the other all atomic data in its possession, including theoretical and developmental information, plant designs, and operational details. This approach, insisted Akers, was the most efficient way of assuring success for the program and, moreover, would be in harmony with the understanding between the President and the Prime Minister.

The position taken by Bush, Conant, and Groves—as worked out among themselves and at meetings of the Military Policy and S-1 Executive Committees—fell considerably short of Akers' view. They were still uncertain about what Roosevelt had told Churchill, and especially about what he now desired, and because they were not convinced that complete cooperation on all phases of the program would necessarily build an atomic bomb any sooner, they preferred that cooperation and interchange of information be restricted to matters that would be of use to each partner in the successful prosecution of the war. The three Americans also shared the suspicion that Akers' arguments most probably were "influenced by an undue regard for possible postwar commercial advantages." [9] Another serious concern was the growing problem of security, which would increase if British scientists were permitted access to all project developments. Finally, too, joint Anglo-American production certainly would complicate production efforts in the United States and might actually impede, rather than speed up, the manufacture of atomic bombs.

From the American view, the extent of atomic cooperation that would be desirable varied according to the specific phase of the program concerned. Bush, Conant, and Groves felt there should be no interchange whatsoever on the electromagnetic separation process, because the British were not working on this method and presumably had no "need to know." Akers replied with the argument that complete cooperation had been agreed upon, regardless of which country developed the idea or of where the production plants were to be built. Progress on one method had a direct bearing on work being done on other methods, he insisted, and there ought to be full interchange on the electromagnetic process.

On the gaseous diffusion process, where the British had done considerable work, the American project leaders were willing to permit unrestricted interchange on experimental and design problems, but felt that exchange of information beyond this was unnecessary. Akers argued that limiting exchange on gaseous diffusion to these aspects was not acceptable. The British should be given full information on construction and operation of the production plant, and British engineers and scientists actually should be employed in it. Not only did this fall within his understanding of the Churchill-Roosevelt agreement, but also, as he emphasized, the British were already working on a diffusion plant.

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[8] Quotation from Ltr, Akers to Conant, 15 Dec 42, HB Files, Fldr 47, MDR. See also Draft Memo, sub: Interchange With British and Canadians on S-1, 15 Dec 42, Incl to Ltr, Conant to C. J. Mackenzie (Canada's Natl Research Council head), 2 Jan 43, HB Files, Fldr 47, MDR; MPC Rpt, 15 Dec 42, MDR; Hewlett and Anderson, *New World*, pp. 264-67; Groves, *Now It Can Be Told*, pp. 128-29; MPC Min, 12 Nov and 10 Dec 42, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; DSM Chronology, 14 Nov 42, Sec. 2(f), OROO; Groves Diary, 13 Nov and 8 Dec 42, LRG; Gowing, *Britain and Atomic Energy*, pp. 148-54.

[9] Groves, *Now It Can Be Told*, p. 129.

As for production data on U–235, Bush, Conant, and Groves held that none should be given to the British because of the fact that their interest in uranium production was only for experimental purposes. The same applied to plutonium. The three Americans were willing to exchange information about scientific findings, but not about the design, construction, or operation of production plants. Heavy water, which might be used to manufacture plutonium, fell into the same category. Akers continued to argue, although in vain, for full British participation in American efforts.

Regarding the work at Los Alamos, Bush, Conant, and Groves proposed that there should be no interchange with the British on information pertaining to weapon research and development. Once again Akers urged full reciprocity of information, and again his arguments were without effect.

As a direct result of these extended discussions, the Military Policy Committee prepared a comprehensive progress report on its views on future U.S.-British relations in the field of atomic energy. The report, dated 15 December, identified "only one reason for free interchange of secret military information between allied nations—namely, to further the prosecution of the war in which both are engaged." [10] The consensus of the committee was that, because the British had now given up any intention of manufacturing atomic bombs or significant amounts of fissionable materials during the war, making production data available to them would not increase their military capabilities. Although the work of British scientists on diffusion and heavy water was well along, the results of their research was not essential to the Manhattan Project; American efforts in these areas were considerably advanced. A complete halt of interchange on diffusion and heavy water would be an inconvenience, but it would not seriously hinder progress of the American program.

Nor did the committee see any moral objections to halting interchange. Both countries had worked on the basic concept, as, indeed, had the Germans. British studies on diffusion probably had benefited from American research, and vice versa. Heavy water had been used in a uranium pile first in France and then in Britain at the instigation of refugee French scientists. But only after the discovery in the United States that plutonium was fissionable by fast neutrons had the British given a high priority to the heavy water program. And, as Conant emphasized, the British had not followed a policy of unrestricted interchange in the past. They had been unwilling to share with American scientists information about several of their own developments—a secret bomb disposal method for one—because they would not help the American military effort.[11]

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[10] MPC Rpt, 15 Dec 42, MDR. Hewlett and Anderson (*New World*, p. 266) state that the section on interchange in this report was drafted by Conant with the concurrence of Groves and Bush.

The committee concluded that halting interchange would not unduly hinder the Manhattan Project, could hardly be regarded as unfair, and had obvious security advantages. However, complete cessation certainly would cause friction with the British and might adversely affect the flow of uranium from Canada and other areas. Thus, in its report the committee recommended that a policy of limited interchange, confined to information that could be used to win the war, should be adopted as national policy.

With the approval of three members of the Top Policy Group, the Military Policy Committee report, a copy of a letter from Akers to Conant restating the British position, and a separate summary by Bush of both British and American views reached the White House on 23 December. Two days after Christmas, Stimson went to see Roosevelt. The British, he had just learned, had signed a treaty with the Soviet Union in September to exchange information on new weapons, including any that might be developed in the future. The treaty, said Stimson, came as a complete surprise and had a direct bearing on any Anglo-American exchange of information. Obviously, it posed the possibility that weapons development data passed on to the British eventually would reach the Russians. This news apparently reinforced the arguments set forth by the Military Policy Committee, and the next day, 28 December, the President told Bush that he approved the committee's recommendations.[12] In so doing, he adopted for the United States a new policy of limited interchange with its atomic partner across the Atlantic—one that restricted collaboration to information of use during the war.

The Quebec Agreement

With the United States' position on limited atomic partnership solidly affirmed, Conant undertook the task of informing both the British and the Canadians. The day after New Year's (2 January 1943), he wrote to Dean C. J. Mackenzie, head of Canada's National Research Council, and explained how the new American policy would affect the work on heavy water under way in Montreal.[13] Then on the seventh, he prepared a lengthy memorandum in which he outlined the specific regulations for Anglo-American cooperation. Because Conant never officially presented this memorandum to the British, it was in effect only a working paper. Its contents, however, generated considerable controversy, and Churchill later complained to presidential aide Harry Hopkins that Conant's memorandum "drastically [limits] interchange of technical information and entirely destroys [Roosevelt's] . . . original conception" of a " 'coordinated or even jointly conducted effort between the two countries.' "[14]

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[11] Note by Conant, in Ms, "Diplomatic History of the Manhattan Project," p. 7n, HB Files, Fldr 111, MDR. That the British were unwilling to provide information on certain of their own developments was not mentioned in the final version of the report submitted to the President. See also Memo, Bush to Hopkins, 26 Feb 43, HLH.

[12] Ltrs, Bush to President, 16 Dec 42, with added note of 23 Dec 42, and President to Bush, 28 Dec 42, OCG Files, Gen Corresp, MP Files, Fldr 25, MDR; Ltr, Akers to Conant, and Draft Memo, sub: Interchange With British and Canadians on S-1, both 15 Dec 42, HB Files, Fldr 47, MDR; Stimson Diary, 26-27 Dec 42, HLS; Gowing, *Britain and Atomic Energy*, pp. 154-55.

[13] Ltr, Conant to Mackenzie, 2 Jan 43, MDR.

Although Akers had read Conant's memorandum, he apparently had elected to keep his thoughts to himself. But on the twelfth, he ran headlong into the practical effects of the new policy at a meeting with Colonel Nichols of the District staff and Percival C. Keith of Kellex. When Akers asked for full exchange of information and access for British scientists to the American diffusion production plant, Nichols informed him that such requests would be "subject to General Groves' decision," the outcome of which the British representative could by now undoubtedly guess.[15]

The problem came to a head on the afternoon of the twenty-sixth at a meeting with Groves and Conant. Akers protested, argued, and bargained, largely in vain, for a relaxation of the American attitude. All he achieved was Groves's statement that America probably would be willing to reopen information exchange on heavy water production if Great Britain would make significant use of it before the end of the war and would indicate a willingness to make slight adjustments regarding interchange on the diffusion process. On other matters—electromagnetic separation, the use of heavy water in a chain reaction, the furnishing of uranium metal and purified graphite to the Canadian group, the chemistry of plutonium, and the design and construction of a weapon—the American project leaders remained adamant. Unsuccessful in his mission, Akers returned home to England a few days later.[16]

Meanwhile, word had reached the Moroccan town of Casablanca, where Churchill and Roosevelt were meeting to discuss Anglo-American strategy. During the military talks the subject of atomic energy was not even mentioned; but, in confidence, the Prime Minister asked the President about the American position on Tube Alloys. Roosevelt's reply, as the Prime Minister related it to Bundy, was to assure Churchill again that atomic energy was a joint enterprise. Hopkins, also present during the exchange, quickly added that the problem could be easily straightened out as soon as the President returned to the White House.[17]

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[14] Quotation from Msg, Prime Minister to Hopkins, 27 Feb 43, HLH. Memo, Conant, sub: Interchange With British and Canadians on S-1, 7 Jan 43, OSRD; the essential points in this memorandum are reprinted in Gowing, *Britain and Atomic Energy*, p. 156. See also Hewlett and Anderson, *New World*, p. 268. Churchill was quoting the letter he received from Roosevelt, dated 11 Oct 41, FDR.

[15] Memo for File, Nichols, sub: Mtg With Akers on Jan 12th, 13 Jan 43, Admin Files, Gen Corresp, 001 (Mtgs), MDR.

[16] Note by Akers and attached extract of his cable, 26 Jan 43, Incls to Ltr, Akers to Groves, 29 Jan 43, Admin Files, Gen Corresp, 091 (British), MDR; Groves Diary, 26 Jan 43, LRG; Msg, Prime Minister to Hopkins, 27 Feb 43, HLH.

[17] Dates of Casablanca Conf: 14–24 Jan 43. Msg, Prime Minister to Hopkins, 16 Feb 43, and Memo, J. M. Martin (principal private secretary for Churchill at Casablanca) to Hopkins, 23 Jan 43, HLH; Memo, Bundy, sub: 22 Jul 43 Mtg at 10 Downing Street, HB Files, Fldr 47, MDR; Richard C. Tolman, sub: Diary of Trip to England, 29 Oct 43, Admin Files, Gen Corresp, 334 (British Interchange), MDR; Hewlett and Anderson, *New World*, p. 270. While Hewlett and Anderson accept Bundy's

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The two leaders parted, Roosevelt to Washington and Churchill to London via the Middle East. Soon after returning home in early February, the Prime Minister apparently received a thorough briefing on Akers' disturbing experience in the United States and, on the sixteenth, he cabled Hopkins to remind him of his assurances given at Casablanca. "The American War Department," complained Churchill, "is asking us to keep them informed of our experiments while refusing altogether any information about theirs." [18]

That Churchill had expressed his perturbation to Hopkins rather than directly to Roosevelt indicates the importance he attached to the problem. The Prime Minister was well aware of Hopkins's close relationship with Roosevelt and regarded him as a "most faithful and perfect channel of communication." [19] A personal representation by "Lord Root of the Matter," as he once called Hopkins, would be more effective than a simple cable direct to the President. Yet, curiously enough, Hopkins apparently knew little about atomic energy matters. Certainly his ready assurances at Casablanca indicated his unfamiliarity with the complexities of the problem. [20]

But in the weeks that followed Churchill's cable, Hopkins set about familiarizing himself with the problem of Anglo-American interchange. Now well briefed by Conant and Bush, and perhaps by Lt. Gen. Brehon B. Somervell, the Army Service Forces (ASF) commander, he replied to Churchill's continued prodding with cables that avoided a direct answer and thus left the American position unchanged. Bush, in turn, reviewed the policy separately with Conant and Stimson and collectively with fellow members of the Military Policy Committee at its 30 March meeting. "None of us," he reported to Hopkins on 31 March, "can see that the present policy, which was approved by the President after it had had the careful review and approval of General Marshall, Secretary Stimson, and Vice President Wallace, is in any way unreasonable, or such as to impede the war effort on this matter. Neither can we see that the application is at present unwise." Supporting a strongly worded memorandum from Conant, which he enclosed, Bush stressed, as had Conant also, the growing American belief that British desire for information about the American program was not for wartime weapons development but, rather, for postwar commercial and industrial application. This might perhaps be considered in another context, said Bush, but it should in no way be allowed to interfere with the Manhattan Project or with the "proper conduct of the secure development of a potentially important

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statement in his memorandum of 22 Jul 43 that at Casablanca Churchill spoke directly to both Roosevelt and Hopkins on Tube Alloys, Margaret Gowing (*Britain and Atomic Energy*, p. 159) suggests that the discussion may have been only between Churchill and Hopkins.

[18] Msg, Prime Minister to Hopkins, 16 Feb 43, HLH.

[19] Winston S. Churchill, *The Second World War: The Grand Alliance* (Boston: Houghton Mifflin Co., 1950), pp. 24–25.

[20] Robert E. Sherwood, *Roosevelt and Hopkins: An Intimate History* (New York: Harper and Brothers, 1948), p. 5. The first reference to atomic energy in the Hopkins papers (HLH) appears on 23 Jan 43, during the Casablanca Conference.

weapon."[21] Apparently convinced of the correctness of the American policy, Hopkins allowed the matter to drag on through April without resolution. Even though he had promised British Foreign Secretary Anthony Eden a telegram that would give his "views fully," he never sent it.[22]

Except for limited exchange between the Montreal and Chicago groups, Anglo-American collaboration slowed almost to a standstill. Sir John Anderson, fearing a weakening of Churchill's negotiating position, refused an American request that chemist Hans von Halban, a refugee from the French atomic program, be permitted to come to New York to confer with Fermi and Urey on heavy water problems, and in partial reaction the Military Policy Committee reduced American support of the heavy water project at Montreal. Hopkins's procrastination did nothing to improve the steadily deteriorating situation, and British scientists began thinking seriously of building their own U-235 plant. During this time, the only answer the British received to Churchill's protests was an indirect one: an explanation of the American position by Bush and Conant to Dean Mackenzie of the Canadian project as he passed through Washington, D.C., on his way to London to discuss the problem with his British colleagues. By then, however, Churchill had decided to pay a personal call on Roosevelt.[23]

The TRIDENT Conference, as Churchill dubbed his third major wartime meeting with Roosevelt, began in Washington on 12 May; however, it was not until the twenty-fifth, his last day in the national capital, that he raised the problem of atomic interchange. Hopkins telephoned Bush, and that afternoon the two Americans met with Professor Frederick Lindemann (Lord Cherwell), the British physicist who was one of Churchill's closest advisers. An able negotiator, Lord Cherwell had already formed some strong opinions about who was responsible for the new American position. The whole situation, he had told Canadian Prime Minister William Lyon Mackenzie King a week earlier, was the fault of the American Army, which had taken over the atomic energy program from the scientists. "They are as difficult about it in their relation with Britain," King noted in his diary, "as Stalin had been in telling of what was being done in Russia." [24]

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[21] Quoted phrases from Memo, Bush to Hopkins, 31 Mar 43 (enclosed is Memo, Conant to Bush, 25 Mar 43), HLH. See also Msgs, Prime Minister to Hopkins, 16 Feb, 27 Feb (two), 20 Mar, 1 Apr 43, and Hopkins to Prime Minister, 24 Feb and 20 Mar 43; Memos, Bush to Hopkins, 26 Feb 43, and Hopkins to Lord Halifax (British ambassador to U.S.), 15 Apr 43. All in HLH. See also MPC Min, 30 Mar 43, MDR.

[22] Memo, Halifax to Hopkins, 14 Apr 43; Msg, Hopkins to Eden, 15 Apr 43 (source of quotation); Memo, Hopkins to Halifax, 15 Apr 43. All in HLH.

[23] Memo, Bush to Hopkins, 27 Apr 43, HLH; Churchill, *Hinge of Fate*, pp. 782–83; Gowing, *Britain and Atomic Energy*, pp. 157–64.

[24] Quoted from J. W. Pickersgill, *The Mackenzie King Record, 1939–1944*, Vol. I (Toronto: University of Toronto Press, 1960), p. 503. For TRIDENT, see Churchill, *Hinge of Fate*, Ch. 20, and Maurice Matloff, *Strategic Planning for Coalition Warfare, 1943–1944*, U.S. Army in World War II (Washington, D.C.: Government Printing Office, 1959), Ch. VI. For Cherwell, see R. F. Harrod, *The Prof: A Personal Memoir of Lord Cherwell* (London: Macmillan and Co., 1959). A less sympathetic view is C. P. Snow, *Science and Government* (Cambridge, Mass.: Harvard University Press, 1961). This account of the meeting at Hopkins's office is based on Memo for File, Bush, sub: Conf With Harry Hopkins and Lord Cherwell at White House, 25 May 43, Incl to Memo, Bush to

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The meeting resulted in an impasse, although it did clarify matters to some extent. After Bush restated the American position and explained the reasons, Lord Cherwell pressed for a change. He denied Great Britain was aiming at any postwar commercial advantage, but admitted the British wanted to be in a position to build atomic weapons once the war was over. During the war, he added, his government was willing to depend on the United States for these weapons, but in the postwar period it could not afford to rely on any other power for military security. Bush and Hopkins immediately pointed out this was a far different question than had been previously discussed. It concerned broader problems of postwar international relations, the solutions to which, Hopkins noted, the Roosevelt administration constitutionally could not commit its successor. Lord Cherwell indicated that if the United States refused to provide the desired information on atomic production, the British might—to guarantee their own future security—have to undertake an immediate production program of their own, diverting whatever was necessary from the main war effort. But he did not put this in the form of an outright threat.

The main question had at last been isolated: Was it necessary for America to provide Britain with production data during the war to ensure her military security in the postwar era? It was clear to Hopkins where the problem lay and he told Bush to do nothing further on the matter. Presumably, Hopkins would take it up with the President.

That evening, Churchill apparently discussed the problem privately with Roosevelt. There is no record of this meeting. Indications are that the President was not informed of the Bush-Hopkins-Cherwell conference. Once again he showed his earlier willingness to cooperate fully with the British. The next morning Churchill cabled Sir John Anderson that the President, foreseeing that the general agreement on wartime interchange would be fulfilled by the almost certain use of the bomb in the war, had "agreed that the exchange of information on Tube Alloys should be resumed and that the enterprise should be considered a joint one."[25]

Whatever Roosevelt told Churchill, he did not pass it on to Bush or Stimson. How much Hopkins knew is not clear, but he was at least aware that Roosevelt had promised Churchill something. A month after TRIDENT, Bush had his first opportunity to brief the President on this talk with Lord Cherwell. Roosevelt seemed impressed, but he said nothing about any arrangements he might have made with the Prime Minister and simply told Bush to "sit tight" on interchange.[26]

Hopkins, 26 May 43, HLH. A copy of Bush's memorandum of 25 May is also in Ms, "Diplomatic Hist of Manhattan Proj," Ann. 9, HB Files, Fldr 111, MDR.

[25] Msg, Prime Minister to Lord President (Sir John Anderson), 26 May 43, quoted in Churchill, *Hinge of Fate*, p. 809. See also Ltr, Roosevelt to Bush, 20 Jul 43; Ltr, Cherwell to Hopkins, 30 May 43; Msg, Prime Minister to Hopkins, 10 Jun 43. All in HLH. The latter message implies that Hopkins may have been present at the Churchill-Roosevelt discussion. On Roosevelt's ignorance of the Bush-Hopkins-Cherwell conference, see Hewlett and Anderson, *New World*, p. 274.

[26] Memo for File, Bush, sub: Conf With President, 24 Jun 43, quoted in Hewlett and Anderson,

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Meanwhile, the British had sent Akers to Ottawa, and during his stay in the Canadian capital, Churchill had cabled Roosevelt once again, seeking to implement their agreement on atomic energy. He received no satisfactory reply. Finally in mid-July, the President asked Hopkins what to do about interchange. Hopkins replied that he [Roosevelt] had "made a firm commitment to Churchill in regard to this when he was here and there is nothing to do but go through with it."[27] Accepting this fact, on the twentieth the President cabled Churchill that he had arranged matters "satisfactorily." The same day he wrote Bush, who was in London attending to other scientific matters, that because "our understanding with the British encompasses the complete exchange of all information," he should "renew . . . the full exchange of information with the British Government regarding the Tube Alloys."[28] The President's letter should have settled the matter. Yet, by one of those peculiar quirks of fate, the new directive did not reach the OSRD director in time to be effective.

On the fifteenth, an unexpected confrontation by an agitated Prime Minister, who daily was becoming more and more disturbed over the interchange problem, had occasioned Bush to refer him to Secretary Stimson, who, with Bundy, also was visiting England. Two days later, Churchill asked Stimson to "help him by intervening in the matter."[29] Harboring strong feelings about the value of close Anglo-American collaboration on all wartime activities, Stimson arranged for a conference on the twenty-second. Shortly before the meeting, the Secretary met with Bush and Bundy. Particularly concerned about the need for careful international cooperation under the new world conditions that atomic energy would create, Stimson questioned Bush carefully and forcefully, and at times the OSRD director felt almost as if he were being cross-examined by the distinguished lawyer. When Bundy suggested constitutional limitations on the President's power to make long-term commitments, Stimson dismissed this as "the argument of a police-court lawyer." But in the end, he agreed that Bush should present the American position to the British as he saw it.[30]

That afternoon, the three Americans sat down with the Prime Minister, Anderson, and Lord Cherwell. Because Churchill, for reasons that are not known, had not yet received Roosevelt's cable, none of the participants were aware of the

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New World, p. 274. Stimson's diary does not indicate that he discussed interchange with Roosevelt during this period. Hopkins's probable knowledge may be inferred from Msg, Prime Minister to Hopkins, 10 Jun 43; Msg, Hopkins to Prime Minister, 17 Jun 43; Ltr, Cherwell to Hopkins, 30 May 43. All in HLH.

[27] Memo, Hopkins to President, 20 Jul 43, HLH. See also Msg, Former Naval Person (Churchill) to Roosevelt, 9 Jul 43, FDR; Memo, Roosevelt to Hopkins, 14 Jul 43, FDR; Gowing, *Britain and Atomic Energy*, pp. 164–65.

[28] Msg, President to Former Naval Person, 20 Jul 43, and Ltr, Roosevelt to Bush, 20 Jul 43, HLH; Hewlett and Anderson, *New World*, p. 275.

[29] Quotation from Stimson Diary, 17 Jul 43, HLS. See also Rpt, Stimson to Roosevelt, sub: Trip to United Kingdom, attached to entry of 10 Aug 43, HLS.

[30] Quotation from Elting E. Morison, *Turmoil and Tradition: A Study of the Life and Times of Henry L. Stimson* (Boston: Houghton Mifflin Co., 1960), p. 617. See also ibid., p. 618; Stimson Diary, 22 Jul 43, HLS; Hewlett and Anderson, *New World*, pp. 275–76.

President's decision to reaffirm a policy of full interchange. Churchill opened the session with a vigorous defense of the British position, emphasizing his fear that unless Great Britain had the means and knowledge of how to develop atomic weapons, Germany or Russia might "win the race for something which might be used for international blackmail." He seemed particularly concerned about the possible atomic threat from Russia, which appeared to be at the root of his worries about the postwar world. If the United States would not "interchange fully," he said, Great Britain would have to undertake its own development "parallel" to that of the Manhattan Project, no matter how this might affect the rest of the war effort.[31]

As diplomatically as possible, Bush attempted to restate the American view and to point out that the main U.S.-British differences lay in the area of "postwar matters." Stimson seconded this approach by reading aloud a short, clear analysis of the situation he had written in preparation for the meeting.[32] The Prime Minister then proposed a five-point agreement to be signed by Roosevelt and himself. Under this agreement, there would be "free interchange" of atomic information within a "completely joint enterprise"; neither government would "use this invention against the other"; neither would "give information to any other parties without the consent of both"; neither would use atomic weapons "against any other parties" without the other's consent; and, finally, "in view of the large additional expense incurred by the U.S.," British commercial or industrial use "should be limited" in whatever way the President deemed "fair and equitable."[33]

Stimson agreed to pass these proposals on to the President. He could not comment officially, but he was obviously pleased. "Satisfactory atmosphere produced,"[34] he noted in his diary. Bush, too, felt somewhat better, for while the Prime Minister's proposed free interchange still seemed dangerous from a security viewpoint, Churchill had made a convincing disclaimer of any postwar commercial motivations. When Churchill received Roosevelt's 20 July message several days after the conference, he was unable to determine from the general terms of the message that the President, in fact, had completely reversed the American position. Only Roosevelt's explicit instructions in his 20 July letter to Bush would have indicated this shift in policy. But the letter of instructions, which the OSRD cabled to Bush on the twenty-eighth, was somehow garbled in transmission or decoding; it ordered Bush to *review,* rather than *renew*, full interchange. Even this mild wording gave Bush some concern, but not nearly as much as the original version would have.[35]

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[31] Memo for File, Bundy, sub: 22 Jul 43 Mtg at 10 Downing Street, MDR. See also Bundy's penciled notes written at the meeting, same file. On the Russian threat see Pickersgill, *Mackenzie King Record*, pp. 532 and 543.

[32] Stimson's penciled notes are filed in HB Files, Fldr 47, MDR.

[33] Memo for File, Bundy, sub: 22 Jul 43 Mtg at 10 Downing Street, MDR.

[34] Stimson Diary, 22 Jul 43, HLS. See also draft of Msg, Stimson to Marshall, unsigned but written in the Secretary's hand, HB Files, Fldr 47, MDR.

[35] Hewlett and Anderson, *New World*, p. 277; Msg, President to Former Naval Person, 20 Jul 43, HLH;

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On the same day Churchill approved a formal draft of the British proposal, which he forwarded to Stimson on the thirtieth. This version, drafted by Anderson and revised by Churchill, was basically the same as the one the Prime Minister had presented orally. It eliminated the specific references to "free interchange" within a "completely joint enterprise," substituted a general statement about pooling "all available British and American brains and resources," and made even more explicit the British disclaimer on "industrial and commercial aspects." Sir John Anderson would go to Washington at once, said Churchill, to help arrange "for the resumption of collaboration." [36]

Back in Washington, Bush learned the actual wording of the President's instructions. He also found awaiting him a strong memorandum from Conant, which reiterated the Harvard president's "conviction . . . that a complete interchange with the British is a mistake" and authorized Bush, if he saw fit, to quote him "on this point to those in higher authority." [37] This proved unnecessary, for the British remained unaware of Roosevelt's actual position and continued negotiating on the basis of American policy as explained by Bush in London.

With the approval of Secretary Stimson, Bush carried out final negotiations with Anderson. He kept in close touch with the Secretary, Bundy, and General Marshall—Vice President Wallace and General Groves were out of town—and especially with Conant, who participated in the opening talks with Anderson on 3 August. Stimson and Marshall also had lunch with the British representative, but their conversation appears to have been more of a general discussion than a bargaining session.

On the sixth, after an exchange of letters, Bush and Anderson came to a meeting of minds on a proposed agreement to be signed by Roosevelt and Churchill. This agreement was based on the four-point draft Churchill had sent Stimson a week earlier, but added a fifth section "to ensure full and effective collaboration." This section provided for establishment of the Combined Policy Committee, which would determine the role of each country, maintain an overall review of the project, allocate critical supplies, and have the final say in interpreting the joint agreement. There would be interchange on all sections of the project. Details would be regulated by *ad hoc* agreements, subject to committee approval, and Bush stipulated that information made available to committee members would be general in nature. Anderson also agreed that the committee would not interfere with the

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Msgs, Bush to Bundy, 27 and 28 Jul 43, HB Files, Fldr 47, MDR; Ltr, Carroll L. Wilson (Ex Asst to Bush) to Roosevelt, 28 Jul 43, FDR.

[36] Ltr, Churchill to Stimson, [30] Jul 43 (date derived from internal evidence), and Incl (draft heads of agreement between President of the United States of America and Prime Minister of Great Britain, 28 Jul 43), HB Files, Fldr 47, MDR. See also Gowing, *Britain and Atomic Energy*, p. 168; Msgs, Roosevelt to Churchill, 26 Jul 43, and Churchill to Roosevelt, 29 Jul 43, FDR.

[37] Memo, Conant to Bush, sub: Exchange of Info on S-1 Proj With British, 30 Jul 43, HB Files, Fldr 47, MDR.

Army's control of the Manhattan Project.[38]

The next day, Bush forwarded the draft agreement and copies of his correspondence with Anderson to the President. He acknowledged the delayed directive of 20 July sent to him by Roosevelt, but then went on to state his conviction that his understanding with Anderson "provided adequately for appropriate interchange, with due regard to the maintenance of security, and with the object of providing the British with all of the information they can utilize in this connection in the prosecution of the war, in return for the benefit of the deliberations of their own scientific and technical groups." [39] In a separate note to Bundy, Bush urged that Secretary Stimson "impress upon the President" the desirability of limiting agreements to wartime objectives and the dangers of making commitments for the postwar period.[40]

General Marshall, too, urged caution, and Bundy strongly recommended to Stimson that the President talk with Bush, or at least carefully read the Bush-Anderson correspondence, before signing any agreement with Churchill. He emphasized to the Secretary that Bush and Conant were trying to protect Roosevelt from any possible charges that he was exceeding his legal authority or acting from any other motivation than a desire to win the war. Strongly impressed by Bundy's urging, Stimson went to the White House on 10 August, determined to make these points. Whether or not he did is unclear, but he did describe the negotiations with Churchill and raise at least one caveat. He asked the President whether a problem might arise from Churchill's proposal that neither country would use atomic energy against third parties without the consent of the other. Roosevelt indicated he saw no danger in the provision.[41]

Even as Stimson met with Roosevelt, the Prime Minister was settling himself in Quebec, in preparation for meeting with the President at the QUADRANT Conference that would begin in a few days. Only then did General Groves, who had been busy on inspection trips to the West Coast and New York, learn of the forthcoming conference and realize the proposed agreement would be discussed. More than half a year had passed since the President had had a report on the Manhattan Project from the Military Policy Committee, and Groves felt Roosevelt should have an up-to-date summary before his meeting with Churchill. Groves drew up a twenty-page report; cleared it with the committee; and, on 21 August, without showing it to Wallace or Stimson, directed Colonel Nichols to hand carry it to General Marshall in Quebec, where QUADRANT was already under way. The report, which covered all Manhattan activities, included a brief summary of relations with the British and, in the light of the Bush-Anderson negotiations, asked the President for further instructions. But when Colonel Nichols arrived in Quebec with the document, General Marshall informed him that Roosevelt and Churchill had already signed an agreement on atomic energy.[42]

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[38] Ltrs, Anderson to Bush, 4 (source of quotation) and 6 Aug 43, and Bush to Anderson, 6 Aug 43, HB Files, Fldr 47, MDR; Ltr, Bush to Anderson, 3 Aug 43, and Incl (extracts from report dated 15 Dec 42), copy in U.S. Department of State, *Conferences at Washington and Quebec, 1943*, Foreign Relations of the United States, [Diplomatic Papers], 1943 (Washington, D.C.: Government Printing Office, 1970), pp. 640–41; Memo, Conant to Bush, sub: Exchange of Info on S–1 Proj With British, 6 Aug 43, HB Files, Fldr 47, MDR; Ltr, Bush to President, 7 Aug 43, FDR; Stimson Diary, 5 Aug 43, HLS; Groves Diary, 3–6 Aug 43, LRG. See also Hewlett and Anderson, *New World*, pp. 277–79; Gowing, *Britain and Atomic Energy*, pp. 168–71.

[39] Ltr, Bush to President, 7 Aug 43, FDR.

[40] Ltr, Bush to Bundy, 6 Aug 43, HB Files, Fldr 47, MDR.

[41] Memo, Bundy to Stimson, 6–7 Aug 43, and attached penciled notes by Stimson; Memo, Bundy to Marshall, 6 Aug 43, and penned comment by Marshall. Both in HB Files, Fldr 47, MDR. See also Stimson Diary, 10 Aug 43, HLS.

The two leaders had approved the proposed agreement at Hyde Park, where Churchill had visited Roosevelt from 12 to 14 August.[43] But it was not until the nineteenth, in Quebec's historic fortress known as The Citadel, that they actually affixed their signatures to the "Articles of Agreement Governing Collaboration Between the Authorities of the U.S.A. and the U.K. in the Matter of Tube Alloys," or, simply, the Quebec Agreement. It called for the earliest possible completion of the Tube Alloys project, ruled out "duplicate plants on a large scale on both sides of the Atlantic," and acknowledged the "far greater expense" borne by the United States. It agreed "never" to "use this agency against each other" and "not to use it against third parties without each other's consent," and it prohibited giving "any information about Tube Alloys to third parties except by mutual consent." In view of the heavier burden carried by the United States, "any post-war advantages of an industrial or commercial character" would be "dealt with . . . on terms to be specified by the President . . . ," and the Prime Minister specifically disclaimed "any interest" in them "beyond what may be considered by the President . . . to be fair and just and in harmony with the economic welfare of the world." Finally, using the Bush-Anderson arrangement for interchange as the basis, the Quebec Agreement established the Combined Policy Committee in Washington, D.C., and designated six members.

On the choice of members, Roosevelt apparently did not consult any of his advisers, except possibly Hopkins. American members were Stimson, Bush, and Conant; British members were Field Marshal Sir John Dill, head of the British Joint Staff Mission in Washington, and Col. John J. Llewellin, Washington representative of the British Ministry of Supply. The sixth member was Canada's Minister of Munitions and Supply, Clarence D. Howe, an American-born engineer whose appointment Churchill had cleared earlier with Mackenzie King. The British had felt that the Canadians, even though they were not a party to the Quebec Agreement, should have representation on the high-level committee because they would be making important contributions to the atomic energy project in Montreal.

The Quebec Agreement set the official basis for Anglo-American atomic relations for the rest of the wartime period. It did not establish the free and open interchange the British had desired and that the President,

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[42] MPC Rpt, 21 Aug 43, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab E, MDR; Groves, *Now It Can Be Told*, p. 135; Groves Diary, 4–23 Aug 43, LRG; MPC Min, 13 Aug 43, MDR.

[43] Pickersgill, *Mackenzie King Record*, p. 543.

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indeed, had offered in his letter of 20 July. It called for "full and effective collaboration," and both Roosevelt and Churchill believed they had provided the basis for it; however, in reality, collaboration would comprise only what was necessary for the war effort, avoiding any form of interchange that might conceivably hinder progress of the Manhattan Project.[44]

Implementing the Agreement

Combined Policy Committee

Despite pressure by Bush and General Marshall, and the presence in Washington of Akers and four leading British scientists who were anxious to implement interchange,[45] two weeks passed before the President revealed the details of the Quebec Agreement to Manhattan officials, including particulars on the Combined Policy Committee. With Churchill visiting at the White House, the President first wanted the Prime Minister's concurrence in the contents of the Military Policy Committee's report before any meeting of the new committee took place.[46]

On 8 September, after lunch at the White House, Stimson discussed the Quebec Agreement with Roosevelt and Churchill. Having learned only that morning that he was to be chairman of the Combined Policy Committee, he asked permission to name ASF chief of staff, Maj. Gen. Wilhelm D. Styer, as his deputy—a request the President and Prime Minister readily approved.[47]

An hour or so later, the first informal meeting of the Combined Policy Committee took place in the Pentagon. One reason for the hasty convening was to accommodate the four British scientists, waiting impatiently to exchange data. Bush was out of town and Howe had not yet arrived from Canada, but Stimson, Conant, Dill, and Llewellin proceeded without them. General Styer was also present, as was Bundy, acting as secretary. They formed a technical subcommittee, with Styer as chairman, to make recommendations on the American and British programs, to prepare directives for interchange of research and development data, and to propose *ad hoc* arrangements for interchange in the area of plant design, construction, and operation. The subcommittee consisted of three scientists who had a thorough knowledge of the American, British, and Canadian projects—Richard C. Tolman, who was General Groves's scientific adviser; Sir James Chadwick, the eminent British physicist; and C. J. Mackenzie of the Canadian National Research Council. Despite some hesitation by Dill and Llewellin about delegating their authority, the Combined Policy Committee authorized the subcommittee to act independently on interchange whenever there was unanimous agreement among its four members.[48]

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[44] The American original of the Quebec Agreement is in HB Files, Fldr 49, MDR. The full text was published in the *New York Times*, 6 Apr 54. A copy of the agreement is also in U.S. Department of State, *Conferences at Washington and Quebec, 1943*, pp. 1117–19. Available records do not indicate that Roosevelt discussed the Quebec Agreement with any American from the time of his conference with Stimson on 10 August until after the document was signed.

[45] Sir Francis Simon of Oxford University, Sir James Chadwick of Cambridge University, and Sir Rudolph E. Peierls and Marcus L. E. Oliphant, both working at the University of Birmingham.

[46] MPC Rpt 21 Aug 43, MDR; Memo, Bush to President, sub: Tube Alloys–Interchange With British, 23 Aug 43, HLH; Memo, Marshall to President, 6 Sep 43, OCG Files, Gen Corresp, MP Files, Fldr 25E, MDR; Memo, Col Frank McCarthy (Gen Staff Secy, OCS) to Marshall, 6 Sep 43 (with Marshall's penned endorsement to Bundy), and Ltr, Dill to Marshall, 7 Sep 43, HB Files, Fldr 7, MDR; Stimson Diary, 7 Sep 43, HLS; Ltr, Bush to Styer, 20 Aug 43, Admin Files, Gen Corresp, 201 (Bush), MDR; paraphrase of Msg, Lord President to Prime Minister, 28 Aug 43, HLH.

[47] Stimson Dairy, 8 Sep 43, HLS; Memo, J. M. M. [Martin] to Prime Minister, sub: Tube Alloys, 9 Sep 43, HLH.

Working Out Interchange Arrangements

Styer's subcommittee met on 10 September, to consider a plan drafted by General Groves and submitted by the Military Policy Committee. Because this plan hewed fairly closely to the earlier American proposals on interchange, it fell considerably short of what the British desired. On weapon development it recommended assignment of two British scientists to Los Alamos under the same security restrictions governing American scientists there. On the gaseous diffusion and heavy water pile processes it suggested interchange of scientific information through a joint committee. On the centrifuge and thermal diffusion processes, which would probably soon be dropped, Styer's subcommittee should decide whether interchange "might affect this decision." As for the electromagnetic and graphite pile processes, on which the British had done little work, interchange would serve no useful purpose, for these methods had reached the stage where changes "would result in serious delay in completion."[49]

The subcommittee, largely at the insistence of Chadwick, recommended some modifications to the plan favorable to the British view. On the gaseous diffusion and heavy water pile processes, interchange should extend to some aspects of development and production. There should be exchange of scientific data on the graphite pile to the extent it might be helpful in the Anglo-Canadian development of the heavy water pile process. Chadwick's contention that the British might be able to contribute to development of the electromagnetic process should be explored by a committee consisting of Groves, Tolman, and Australian physicist Marcus L. E. Oliphant. In keeping with the Military Policy Committee's recommendations, the subcommittee reached agreement on possible personnel for other committees or representation needed to carry out interchange on the various processes. Chadwick and Sir Rudolph E. Peierls, the University of Birmingham physicist, would serve as British representatives at Los Alamos; von Halban with Metallurgical Project Director Arthur Compton, or one of his principal assistants, as a committee to exchange data on the heavy water pile process; Sir Francis E. Simon, physicist at Oxford's Clarendon Laboratory, and Peierls with Keith, the Kellex head, and Urey on a gaseous diffusion committee; and Oliphant, Simons, and Peierls on a committee with American representatives desig-

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[48] CPC Min, 8 Sep 43, and Ltr, Llewellin to Bundy, 10 Sep 43, HB Files, Fldr 9, MDR. See also earlier draft of Bundy's minutes, same file. Stimson Diary, 8 Sep 43, MDR.

[49] MPC Min, 9 Sep 43 (source of quotation), MDR; Tech Subcommittee Min, 10 Sep 43, HB Files, Fldr 28, MDR. See also MPC Rpt, 15 Dec 42, MDR.

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SIR JAMES CHADWICK *(left) consulting with General Groves and Richard Tolman on Anglo-American interchange*

nated by Bush or Conant to decide the extent of interchange on the centrifuge and thermal diffusion processes.[50]

Despite the considerable progress made by the subcommittee, there was little specific interchange in the weeks that followed. Part of the difficulty lay in the lack of specific working procedures. To set these up, Tolman went to England in October to consult with Chadwick and other British scientists and with Sir John Anderson. General Groves, who was becoming increasingly impatient to implement interchange in those areas where it was sanctioned, closely monitored Tolman's negotiations from his Washington office and attempted to facilitate Anglo-American coordination by keeping members of the Military and Combined Policy Committees regularly informed.[51]

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[50] Tech Subcommittee Min, 10 Sep 43, MDR.

[51] In Admin, Files, Gen Corresp, MDR, see following files: 334 (British Interchange), for information on Tolman's trip; 201 (Conant) for Memo, Groves to Conant, 2 Nov 43; 680.2 for Ltrs, Llewellin to Groves, 10 Nov 43, with enclosed draft, and Groves to Llewellin, 12 Nov 43; 371.2 (Scty) for Ltrs, Capt Horace K. Calvert (Intel and Scty Sec chief) to Lt Col John Lansdale (Groves's Spec Asst for Scty), sub: Visit of British Natls to DSM Proj 7 Oct 43, and Maj Robert S. Furman (Groves's Spec Proj Off) to Calvert, same sub, 21 Oct 43. See also MPC Min, 14 Dec 43 (with Memo, Groves to MPC, 10 Dec 43, as Att. 1), MDR; Memo, Styer to CPC, 14 Dec 43, HB Files, Fldr 28, MDR; CPC Min, 17 Dec 43, HB Files, Fldr 10, MDR; MPC Rpt, 4 Feb 44, Incl to Ltr, Groves (for MPC) to President, same date, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab C, MDR; Groves Diary, 27 Oct, 2 and 4 Nov 43, LRG. For the British perspective on drawing up

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When Groves received word that another team of British scientists soon would be arriving in the United States, the need for a speedy procedural agreement on interchange became even more critical to him. Yet not until mid-December were the British and Americans able to complete interchange procedures. With the approval of the Military and Combined Policy Committees, the new procedures went into effect on the fourteenth. Naming Chadwick as the "immediate scientific adviser to the British members" of the Combined Policy Committee, the terms of this agreement permitted that he have "access" to all work on "research and plant scale" on both sides of the Atlantic. The slight and unassuming Cambridge professor, who, surprisingly enough, got along exceptionally well with the robust and outspoken Groves, would also help guide experimental work at Los Alamos, where he would be joined by a small number of other British scientists. Peierls, and one or two others, would work with Kellex on the diffusion process and also would discuss theoretical problems of bomb construction with American scientists; he could not, however, visit Los Alamos. Oliphant and six assistants would work with Ernest Lawrence at Berkeley on research and design and then move to Los Alamos to assist on ordnance problems. Oliphant would continue his close contacts with the electromagnetic project during production and would be free to visit England to supervise any similar research there. About fifteen British scientists and industrialists, led by Akers, would exchange information on diffusion at Columbia University and Kellex. Research on heavy water piles at Montreal would be continued under a joint program to be worked out with those doing similar work in the United States.[52]

This arrangement was, in effect, the implementation of the Quebec Agreement. While it did not actually provide full information exchange, it went further than most members of the Manhattan Project administrative staff would have preferred. Certainly the arrangements were more liberal than Groves would have wished, although he later claimed full credit for having drawn up these "rules regulating the . . . British scientists."[53] While anxious to get any British help that might speed the progress of the American program, he was generally opposed to providing Great Britain with anything more than was absolutely necessary to gain this aid. "I was not responsible for our close cooperation with the British," he asserted a decade later. "I did everything to hold back on it."[54]

By the end of January 1944, eighteen British scientists had reached New York, Washington, D.C., Berkeley, and Los Alamos, and more were expected. Only one problem remained outstanding, namely, arrangements for cooperation between the Montreal and Chicago scientists on

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interchange arrangements see Gowing, *Britain and Atomic Energy*, pp. 233–34. Colonel Llewellin was replaced on the CPC by Sir Ronald I. Campbell, a veteran member of the British embassy staff in Washington.

[52] Memo, Groves to MPC, 10 Dec 43, Att. 1, MDR; MPC Min, 14 Dec 43, MDR; Gowing, *Britain and Atomic Energy*, pp. 234 and 236–37.

[53] Groves, *Now It Can Be Told*, pp. 136–37.

[54] *Oppenheimer Hearing*, p. 175.

pile research. Around the middle of the month, senior members of both groups had discussed a joint program of research that would lead to the construction of a heavy water pile. Yet to Manhattan leaders in Washington, it seemed doubtful the venture would be of significant value during the war, and Groves and Conant, at least, preferred that it should not begin.[55]

On 17 February, however, at the next meeting of the Combined Policy Committee, Chadwick pressed for approval of a Canadian heavy water pile to undertake large-scale production of plutonium. Great Britain and Canada would provide the funds, the United States the heavy water, and the three nations would exercise joint control over the project. Neither Groves, who was not a committee member, nor Styer was present, but Bush and Conant apparently raised some questions. Would the project result in militarily significant production before the end of the war? Was it advisable to use up resources, especially ore? The committee turned the problems over to a subcommittee composed of Groves, Chadwick, and Mackenzie.[56]

The subcommittee discussed a heavy water pile with Compton, Fermi, and others at Chicago and with von Halban and his colleagues at Montreal. Then, on 6 April, it submitted its report to the Combined Policy Committee. The Hanford Engineer Works, the subcommittee concluded, would produce enough plutonium to satisfy "essential military needs" for the war, and production at the proposed Canadian plant could not begin in time "to have an appreciable influence on the outcome of the present war." On the other hand, the potentialities of the heavy water pile were so great that its development could not be "wholly neglected." Accordingly, it recommended continued research and development at both Chicago and Montreal, with an increased staff and the appointment of a director for the Canadian project; the design and construction of a heavy water pilot pile in Canada by the United States, Great Britain, and Canada; and future consideration of a small production pile when the experimental stage was further advanced. A week later the Combined Policy Committee adopted this program, and in the ensuing months Groves, Chadwick, and Mackenzie continued to keep an eye on the project for the committee and see to it that the approved recommendations were carried out.[57]

The new Montreal director was physicist John D. Cockcroft, and his staff was rapidly reinforced with British and Canadian scientists. In early May, as plans for construction of the pilot plant matured, General Groves approved an isolated site previously selected by the Canadians, near Chalk River, Ontario, on the south bank of the Ottawa River and about 110 miles northwest of the Canadian capital. (*See Map 2.*) Late in the month, Cockcroft, von Halban, and others from Montreal visited Chicago. A second meeting was held in Montreal two weeks later. Discussion was limited by the rules governing interchange that Groves, Chadwick, and Mackenzie were in the process of drafting. These regulations, which the Combined Policy Committee approved formally on 19 September, limited interchange to information necessary for the design, construction, and operation of the Chalk River pilot plant. Scientists at Montreal could learn about the pilot pile at Clinton and the research piles at Argonne, and receive basic scientific data essential to the heavy water pile. They were not to be furnished with information about production plant construction at Hanford or the chemistry of plutonium or the method of separating that element, because these developments were not necessary for work at Chalk River. Finally, the regulations directed that the Montreal group should establish strict security in the transmittal of all data.

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[55] MPC Rpt, 4 Feb 44, MDR; Laurence, "Canada's Participation in Atomic Energy Development," p. 325; Hewlett and Anderson, *New World*, p. 282.

[56] CPC Min, 17 Feb 44, OCG Files, Gen Corresp, MP Files, Fldr 9, Tab B, MDR; Stimson Diary, 17 Feb 44, HLS; Hewlett and Anderson, *New World*, pp. 282–83.

[57] Rpt, Groves, Chadwick, and Mackenzie to CPC, sub: Joint Development of Heavy Water Pile, 6 Apr 44, HB Files, Fldr 28 (also in Fldr 103), MDR. See also CPC Min, 13 Apr 44, DS, and pertinent documents in HB Files, Fldrs 12 and 105, MDR.

General Groves designated Maj. Horace S. Benbow as his liaison officer at Montreal, or Evergreen, to use its code name, and directed that the Chicago area engineer handle all Evergreen requests. For scientific liaison, Groves assigned physicist William W. Watson and chemical engineer J. R. Huffman to report directly to him rather than the Metallurgical Laboratory director.[58]

The policy established in the spring of 1944 for interchange on the Canadian project completed the arrangements approved the previous December for Anglo-American information exchange on atomic energy and fulfilled the terms of the Quebec Agreement of August 1943. British scientists were now working with Americans in the United States on several phases of the overall program and were reviewing a limited amount of information. In the remaining months of the war, Anglo-American relations steadily improved, although, inevitably, minor problems arose.[59]

Patent Problems

One of the problems relating to interchange with which the Combined Policy Committee had to concern itself periodically during 1943 and 1944 was patent rights. The United States and Great Britain in August 1942 had concluded an executive agreement on exchange of patent rights that provided a general basis for negotiating more specific arrangements applicable to particular areas of interchange.[60] At the time of this agreement, Sir John Anderson had suggested to Bush the adoption of a joint patent policy relating specifically to atomic energy as an important aspect of international control. Bush, however, did not think the time was propitious for establishing such a policy; instead, he recommended that participating countries could facilitate eventual estblishment of controls by seeing to it that most patent rights concerning atomic energy within their own borders were publicly owned.[61]

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[58] Rpt, A. W. Nielson and W. H. Sullivan, sub: Review of Liaison Activities Between Canadian and United States Atomic Energy Projs, 19 Feb 47, HB Files, Fldr 103, MDR; Rpt (to CPC), sub: Progress on Canadian NRX Proj, 24 Aug 44, HB Files, Fldr 103, MDR; MDH, Bk. 1, Vol. 4, "Auxiliary Activities," Ch. 9, DASA; MPC Min, 10 May 44, MDR; DSM Chronology, 7 and 15 Jun 44, each Sec. 15, 8 jun 44, Sec. 2(b), and 12 Jun 44, Sec. 7, OROO; CPC Min, 19 Sep 44, HB Files, Fldr 13, MDR; Groves Diary, May–Jun 44, LRG; Ltr, Howe to W. L. Webster (British Supply Council in North America), 29 Apr 44, HB Files, Fldr 12, MDR. See also Evergreen progress reports, etc., HB Files, Fldr 32, MDR.

[59] For details on British implementation of interchange see Gowing, *Britain and Atomic Energy*, pp. 239–44.

[60] U.S. Department of State, *Interchange of Patent Rights, Information, Inventions, Designs, or Processes: Agreement Between the United States of America and Great Britain, Signed at Washington, August 24, 1942*, Executive Agreement Series 268, Pub 1803.

The need for patent arrangements became even more obvious after the signing of the Quebec Agreement. With scientists of both countries working together, a common policy was necessary to protect both individual and national rights. Secrecy and security aspects further complicated the difficult technicalities inherent in all patent matters.

In the fall of 1943, Arthur Blok, patent expert in the British Department of Scientific and Industrial Research, and Capt. Robert A. Lavender, retired American naval officer who advised Bush and later Groves on patent questions, attempted to reach some agreement. They concluded that the 1942 agreement did not apply to atomic developments and drew up a new proposal.[62] When Bush pointed out certain inadequacies in the Blok-Lavender proposal at the Combined Policy Committee on 13 April 1944, the committee referred the problem to its recently appointed joint secretaries, Harvey Bundy and W. L. Webster of the British Supply Council. During the summer the two men studied the question, conferring frequently with Lavender, Blok, Bush, and others; and in September, they drew up a lengthy administrative procedure, which the committee approved at its meeting on the nineteenth. But project lawyers found that the procedure was in conflict with the United States patent law, and not until February 1945 was it properly amended. As finally approved at the 8 March committee meeting, the arrangement was still an *ad hoc* procedure, neither final nor complete, leaving the negotiation of a permanent settlement to the future.[63]

New Partnership Strains: Repatriation of French Scientists

The liberation of France following the Allied invasion of Western Europe in the summer of 1944 placed new strains upon the British-American atomic partnership.[64] The imme-

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[61] Ltr, Anderson to Bush, 5 Aug 42, MDR; Hewlett and Anderson, *New World*, pp. 262-63.

[62] Ltr, Blok and Lavender to CPC Subcommittee, 1 Oct 43 (recommendations were shown to Chadwick but submitted directly to the CPC, because Styer's group was not familiar enough with patent problems to add anything to basic suggestions); Memo, Webster to Bundy, sub: Memo on Patents Signed by Arthur Blok and Capt Robert A. Lavender, 7 Mar 44. Both in HB Files, Fldr 18, MDR. Groves, *Now It Can Be Told*, pp. 418-20.

[63] In HB Files, MDR, see following files: Fldr 18 for Memo, Bundy and Webster to CPC, sub: Certain Aspects of Patent Matters Arising from Special Proj, 18 Sep 44 (containing drafts and related correspondence); Fldr 47 for Ltrs, Webster to Howe, 26 Aug 44, and Howe to Webster, 29 Aug 44; Fldr 13 for CPC Min, 19 Sep 44; Fldr 18 for Memo, Bundy to Lavender, sub: Annex A to CPC Memo, 2 Apr 45 (containing drafts and related correspondence); and Fldr 46 (copy in Fldr 105) for CPC Min, 8 Mar 45.

[64] Except as indicated, section on problem with French scientists based on HB Files, Fldr 36 (French Situation) and Fldr 55 (S-1 U.S. Cables), MDR;

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diate source of the dispute was the repatriation of five French scientists—Hans von Halban, Pierre Auger, Lew Kowarski, Jules Gueron, and Bertrand Goldschmidt—who had fled to England from France after the German invasion in 1940 and then gone on to Montreal in 1943 to work in the Canadian atomic program. When they began to apply for permission to visit or return permanently to their homeland, American atomic leaders contended such visits posed too great a security risk, particularly because physicist Frederic Joliot-Curie, head of the French atomic program, was known to be a member of the Communist Party.

The Americans, and especially General Groves, took the view that the French should not be allowed to go back to France until the war was over. In May 1944, when Pierre Auger terminated his employment with the Canadian project, citing a desire to return to France to assist Joliot-Curie in rebuilding French science, Groves and the British representatives in America agreed that neither he nor any of the other French scientists in Canada should be permitted to do so and that measures should be taken to prevent any atomic information from reaching that country. Nevertheless, when Auger went to London in August to become a full-time member of the French Scientific Mission in that city, British authorities permitted him to visit France.

In October, Gueron requested permission to visit France on personal matters. Groves, who had learned that Gueron planned to see Joliot-Curie, opposed the visit because Gueron knew a great deal about the atomic project and was reputed to be an "ardent Free Frenchman" and supporter of General Charles de Gaulle. But British authorities indicated they had agreed to let Gueron go. When Groves learned this, he determined to have the French scientist kept under surveillance by Manhattan security personnel while in France. The British objected strongly. Gueron was "a man of integrity," they asserted, and ought not to be treated as if he were a prisoner.[65]

Manhattan leaders interpreted these British actions to be a clear violation of the terms of the Quebec Agreement, which forbade communication of atomic information to third parties without mutual consent, and requested the American ambassador in London, John G. Winant, to secure an explanation. Sir John Anderson replied that the British had made agreements with the French scientists before they went to Canada. The first to come to England—von Halban and Kowarski—had negotiated an agreement for exchange of patent rights relating to atomic energy between France and the United Kingdom. Later when Auger, Gueron, and Goldschmidt reached England, they had worked out employment arrange-

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OCG Files, Gen Corresp, MP Files, Fldr 12 (Intel and Scty), Fldr 16 (Special Rpts), and Fldr 26, MDR; Hewlett and Anderson, *New World*, pp. 331–35; Groves, *Now It Can Be Told*, pp. 224–29; Bertrand Goldschmidt, *The Atomic Adventure: Its Political and Technical Aspects*, trans. Peter Beer (Oxford, England, and New York: Pergamon Press and Macmillan Co., 1964), pp. 12–43; Wilfrid Eggleston, *Canada's Nuclear Story* (London: Harrap Research Publications, 1966), pp. 29–181; Gowing, *Britain and Atomic Energy*, pp. 289–96 and 343–46.

[65] Quotations from General Groves's memorandum (26 Dec 44) to Secretary of War on French situation, HB Files, Fldr 36, Tab K, MDR.

ments that assured them their right to return to France as soon as the war made it feasible and also their status as French civil servants and as adherents of General de Gaulle and the Free French. Because the French scientists had made a "very special contribution" to the Tube Alloys project, in the form of "research already started by Joliot and by his action at the time when France was over-run," Sir John contended the French had "a better claim than any other fourth country to participate in any post-war T. A. arrangements," and he did not think it wise to embark on a course of action that would "lead the French authorities to raise the matter prematurely and with a sense of grievance already established." [66]

Anderson's revelation came as a shock to leaders of the American program. Except for some information on British acquisition of rights under von Halban's patents that Vannevar Bush had learned about earlier, they had known nothing about the agreements between the British and French scientists. Sir John had not mentioned them during negotiations for the Quebec Agreement, yet, as Groves saw it, these third-party obligations were in obvious contradiction to that agreement. He also thought Sir John was wrong to feel he had to placate Joliot-Curie and furnish him with information about the American project.

Consequently, Groves expressed some reluctance in consenting to a British request in November 1944 that von Halban be allowed to visit London, with the understanding that the French scientist would not be allowed to go to France. But as soon as von Halban arrived in England, Sir John went to Ambassador Winant with the plea that von Halban should be permitted to see Joliot-Curie to ensure preservation of the status quo with France. Faced with Sir John's insistent request, Winant asked Groves to come to London to talk with the Chancellor, but Groves did not go because he was too involved in urgent atomic project matters. Under continuing pressure from Sir John, Winant finally consented to von Halban's visit to Paris. The British provided the French scientist with an agenda establishing limits for information about the American atomic project that he was to give to Joliot-Curie, but Manhattan intelligence agents learned subsequently that von Halban had furnished the French atomic chief with much additional highly secret data about the American project. There were strong indications, too, that Joliot-Curie himself was shortly going to request assignment to work on the Manhattan Project. [67]

When Groves learned of von Halban's visit more than a week after it had taken place, he determined to bring an end to what he perceived as a deliberate British policy to secure postwar commercial advantage in the atomic energy field largely at the expense of the United States. As Groves saw it, Anderson was continuing to permit disclosure to the French of important information relating to atomic research that had been "developed by Americans with American money, and given to the British pursuant to interchange agreements subsidiary to the Quebec Agreement." [68]

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[66] Sir John Anderson's reply was sent in the form of an *aide-memoire*, a copy of which is in HB Files, Fldr 18, Tab J, MDR. See also at Tab J, Memo, Groves to Winant, 31 Oct 44, and Incl (comments by Maj William A. Consodine, a Manhattan security officer). Consodine explains how he obtained a copy of the *aide-memoire* for the Manhattan commander in Memo (extract), Consodine to Groves, received on 28 Oct 44, HB Files, Fldr 107, MDR.

[67] See correspondence relating to von Halban case in OCG Files, Gen Corresp, MP Files, MDR. In Fldr 26, Tab I, especially Memo, Lansdale to Groves, 2 Dec 44; Draft Transcription of Lansdale Notes and Rpt, Hans [von] Halban to Akers, sub: Nov 24–Dec 5 Visit to France, 5 Dec 44. In Fldr 16, Tab A, Ltr, Richard W. Perrin to W. L. Gorell Barnes (both British Foreign Svc officials), 8 Dec 44.

On 14 December, Groves wrote to the Secretary of War, stating that "pending the receipt of instructions from you, I will take steps to safeguard the security of the DSM project by delaying insofar as practicable the passing of vital information concerning it to the representatives of any government other than our own." [69] Stimson met with Groves, Bundy, and Harrison the next day. He informed them he would take the matter up with the President at the earliest opportunity. He instructed Groves to prepare a complete resume of the French situation and requested Bundy to notify Ambassador Winant that, until the Combined Policy Committee met to discuss the situation, he should refer to Washington "any further British proposals for disclosures or contacts which might lead to disclosures to the French. . . ." [70]

It was not until 30 December that Stimson was able to see the President. Groves accompanied the Secretary to the White House and the two reviewed for Roosevelt the entire French problem, emphasizing that Anderson appeared to have deliberately deceived Winant and other American representatives in England regarding Britain's commitments on atomic energy matters to France. Roosevelt's reaction was that Winant had been "hoodwinked." What, he wished to know, were the French after? Stimson and Groves said they believed France wanted to secure a full partnership in the tripartite atomic agreement. Roosevelt indicated that France in its current unstable political situation was not a suitable partner and, even if it were, he saw no justification for letting it share in the partnership. The discussion then turned to other matters relating to the atomic energy program. [71]

With the backing of the President, Stimson and Groves, assisted by Bundy, endeavored to prevent further disclosures of atomic secrets to the French during the winter and spring of 1945. [72] They had a statement ap-

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[68] Memo, Groves to Secy War, 26 Dec 44, HB Files, Fldr 36, Tab K, MDR; Groves, *Now It Can Be Told*, pp. 226–27.

[69] Ltr, Groves to Secy War, 14 Dec 44, HB Files, Fldr 36, Tab L, MDR.

[70] Msgs, Bundy (sent by Groves) to Winant, 26 Dec 44 (source of quotation), and Winant to WD, 27 Dec 44, HB Files, Fldr 55, MDR; Stimson Diary, 15 Dec 44, HLS. Groves's resume is in Memo, Groves to Secy War, 26 Dec 44, MDR.

[71] Memo, Stimson, sub: Conf With President, 30 Dec 44; Memo for File, Groves, 30 Dec 44; Memo, Groves to Chief of Staff, 30 Dec 44; Notes by Stimson To Aid in Preparation of Agenda for Mtg of President and Secy War with Groves. All in OCG Files, Gen Corresp, MP Files, Fldr 24, MDR. Stimson and Groves Diaries, 30 Dec 44, HLS and LRG.

[72] In HB Files, MDR, see the following files: Fldr 14 (copies in Fldrs 22 and 105) for CPC Min, 22 Jan 45; Fldr 46, Tab C, for Memo, Howe to CPC, 6 Mar 45; Fldr 103 for Ltr, Mackenzie to Stimson, 8 Mar 45; and Fldr 107 for Memo, Groves to Secy War, 13 May 45, and Incl, Ltr, Chadwick to Groves, 8 May 45. See also Stimson Diary, 19 and 22 Jan 45, HLS. The Secretary of War makes no mention in his diary of later developments in the French situation in the spring and summer of 1945.

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proved by the Combined Policy Committee for Sir John Anderson to use if, as anticipated, the French requested full participation in the atomic energy program. The gist of this statement was that, for reasons of security, all detailed discussion of atomic matters with the French must be postponed until the end of the war, when the British would guarantee "fair treatment of any claims . . . relating to commercial or industrial applications of nuclear sources of power." [73]

When Sir John met with Joliot-Curie on 23 February in London, he did not present the formal statement, but he did adhere generally to the policy set forth in it. He indicated that, because of the continuation of the war and because British leaders could not readily get together with their French counterparts, progress on shaping postwar policies had not been possible. Anderson found that Joliot had concluded from the favorable British actions with regard to von Halban and Gueron, and the other French scientists, that Great Britain recognized the interests of France in atomic energy matters and, in the postwar period, would strongly support her in the pursuit of these interests.

Fear that there might be another breakdown in Anglo-American interchange if he persisted in his strong support of French atomic interests appears to have engendered a modicum of moderation in Sir John; however, he persisted in efforts to have British leaders propose that the French be assured of greater participation in atomic matters as soon as security considerations made this feasible. Two pressing concerns motivated Sir John's actions: his belief that Britain owed this support to the French atomic scientists for their contribution to the British and Canadian atomic programs, and his fear that any policy that offended France might drive her into the Russian camp in the postwar period.

In March 1945, Bundy and Groves worked out an acceptable arrangement with the British and Canadian authorities for keeping the French atomic scientists (except Auger who was now in Paris working with Joliot) in the United States or Canada until the war was over. In early May, Auger's status temporarily gave cause for concern when word reached Groves through Chadwick that Joliot, under pressure from one of the ministers in the French government, felt compelled to begin an active atomic energy program, including a survey of French territories for uranium and the start of research projects for the preparation of pure uranium metal and graphite. But Auger assured British scientists he would take no active part in the proposed program, and by summer of 1945 atomic developments in the United States had reached a point where the French problem no longer constituted a major threat to the security of the Manhattan Project. [74]

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[73] Paper, [Bundy], sub: Problems With Respect to the French, 19 Jan 45, HB Files, Fldr 36, Tab I, MDR.

[74] Memo, Groves to Secy War, 13 May 45, and Incl: Ltr, Chadwick to Groves, 8 May 45, MDR; Rpt, sub: Summary [of French Situation], Incl to Memo, Groves to Secy State James F. Byrnes, 13 May 45, OCG Files, Gen Corresp, MP Files, Fldr 12, Tab D, MDR.

CHAPTER XI

Security

The leaders of the American atomic energy program, aware of the tremendous military potentiality of atomic weapons and reports of German atomic research, recognized almost from the beginning the need for maintaining a high degree of secrecy. An important factor in their decision in early 1942 to turn over administration of the program to the Army was their conviction that it was the organization best prepared during wartime to enforce a foolproof system of security. Such a system would ensure that he Axis powers remained ignorant of Allied interest in developing atomic weapons; reduce the likelihood that he Axis states, particularly Germany, would accelerate their own efforts to produce atomic weapons and under-ake espionage and sabotage activities gainst the American program; and, most significantly, from the standpoint of military effectiveness, aliow he Allies to employ these weapons gainst the Axis nations with maximum surprise.[1]

Early Aspects

First efforts to establish security in atomic matters had occurred in 1939, when refugee physicists in the United States attempted to institute a voluntary censorship on publication of papers concerning uranium fission. American scientists did not accept this suggestion initially, but the outbreak of World War II brought home to many of them the need for control over publications relating to atomic fission. To formalize a censorship program, the Division of Physical Sciences of the National Research Council in April 1940 established a committee that succeeded in getting most scientists to withhold publication of papers on sensitive subjects, particularly those concerned with uranium fission.[2]

In June, when the government-sponsored Committee on Uranium became a subcommittee of the newly constituted National Defense Research Committee (NDRC), it also became subject to the security measures currently in effect for federal agencies. The NDRC, knowing that it was to be concerned chiefly with projects for the Army and Navy, adopted security regulations that conformed to those of the two military services. Under these regulations NDRC subcommittees were required to adhere to a policy of strict compartmentalization of information, to classify all sensitive materials, and to obtain security clearances for all employees.

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[1] Knowledge of the progress of the Germans, or he other Axis states, in atomic research and development was not based upon precise and accurate in-lligence information, for such was not available to e Allies. Nevertheless, because the Allies lacked pecific information to the contrary, they had to sume that at least Germany would make a serious tempt to develop atomic weapons. See Rpt to President, sub: Status of Tube Alloys Development, 9 Mar 42, Incl to Ltr, Bush to President, same date, HB Files, Fldr 58, MDR; DSM Chronology, 26 Sep 42, Sec. 2(e), OROO; MDH, Bk. 1, Vol. 14, "Intelligence & Security," p. 1.1, DASA; Groves, *Now It Can Be Told,* 140–41; MPC Rpt, 7 Aug 44, Incl to Memo, Groves to Chief of Staff, same date, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab K, MDR.

[2] On the early efforts to establish a voluntary censorship program see the Prologue to this work and the Smyth *Report,* pp. 331–32.

Transfer of the NDRC uranium program to the Office of Scientific Research and Development (OSRD) in November 1941 did not significantly alter existing security arrangements, because the OSRD patterned its own security system largely along the lines of the NDRC program. As the OSRD became more involved in negotiation and administration of contracts with industrial and research organizations, however, it expanded its security controls to provide a more adequate coverage, adding security measures for personnel administration, classified information, and plant protection.[3]

The modest OSRD security system sufficed until, in the spring of 1942, the start of the uranium program's rapid expansion—the letting of numerous contracts with industrial firms; the employment and interaction of ultimately tens of thousands of workers, scientists, and engineers; and the formation of complex organizations to construct and operate the large-scale production plants and their atomic communities—enormously complicated the problems of security just at the time the Army undertook its new role as project administrator. Although these measures were necessary for the more rapid achievement of a successful fission weapon, they also tended to weaken security.[4] Consequently, the Army almost immediately undertook a reorganization and expansion of the existing OSRD security system and, eventually, also endeavored to bring the system more directly under control of the Manhattan District. The system that finally evolved was in many respects unique and introduced a number of innovations in technique and organization that subsequently would be adopted as standard features of government security programs.

The District's Security System

The security system, as it took form in the newly established Manhattan District, resembled that already in existence in most other engineer districts. Under Army regulations in force in 1942, the security program of an engineer district was limited to routine local security requirements. When broader problems arose, the district engineer or security officer could call upon the resources of the Assistant Chief of Staff, G–2, in the War Department. Since June 1939, under provisions of a presidential proclamation, the War Department's Military Intelligence Division (MID) had shared responsibility for matters of espionage, counterespionage, and sabotage in the United States with the Federal Bureau of Investigation (FBI) and the Office of Naval Intelligence. In the latest revision (February 1942) of this Delimitations Agreement—so designated because it set forth the area of jurisdiction of each agency—the MID's assignment was to cover the military establishment, including War Department civilian employees and civilians on military reservations or under military control, plus a large part of the munitions industry.[5]

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[3] Stewart, *Organizing Scientific Research for War*, pp. 27–31 and 246–55.

[4] Ibid., pp. 246–47; Ltr, Compton to Conant, 8 Dec 42, Admin Files, Gen Corresp, 319.1 (Rpts), MDR. Compton's letter to Conant complained that the security-inspired policy of compartmentalization was delaying determination of the purity standards that must be met for the plutonium to be employed in an atomic weapon. This well illustrates the recurring conflict in the Manhattan Project between the demands of the program and the requirements of security.

Organization and Scope

Colonel Marshall, in organizing the Manhattan District security program soon after becoming district engineer in June 1942, formed the Protective Security Section. Under direction of a member of Marshall's staff, this section emphasized such aspects as personnel, plant, and military information security. At the same time, to provide the District security staff with counterintelligence assistance, Marshall arranged with the Assistant Chief of Staff, G–2, Maj. Gen. George V. Strong, for security liaison with the MID's operating element, the Military Intelligence Service (MIS). From his staff, General Strong assigned counterintelligence responsibility for the atomic project to Maj. John Lansdale, Jr., who had been a lawyer in civilian life.

Because effective security operations required maximum secrecy, Major Lansdale personally visited the Western Defense Command G–2 and each service command and requested that they each select an officer to report directly to him, bypassing both the G–2 and the commanding general of each service command.[6] To further facilitate carrying out the internal security functions for the atomic project, Lansdale also organized a quasi-clandestine counterintelligence group. This group operated under cover of the Investigation Review Branch, Assistant Chief of MIS for Security, which Lansdale headed. He reported directly to General Groves, and his group in effect was answerable to the Manhattan Project commander in all substantive respects, even though it functioned from the G–2 office in the Pentagon.[7]

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[5] MDH, Bk. 1, Vol. 14, p. 7.1, DASA, OCE Cir 1070, sub: Org for Protective Scty Svc in OCE Constr Div and in Office of Div and Area Engrs, 15 Jun 42, CE 025.1 CXP, Engrs Library, Fort Belvoir, Va.; Ms, Capt C. J. Bernardo, "Counterintelligence Corps History and Mission in World War II" (Fort Holabird, Baltimore, Md.: CIC School, n.d.), pp. 4 and 13, NARS; Ms, Army Service Forces, Intelligence Division, "History of the Intelligence Division," 4 vols. (Army Service Forces, ca. 1946), 1(2):13–14, 1(8):1–2, 1(9):10–11, NARS; Groves, *Now It Can Be Told*, p. 138.

[6] An organization formerly called a corps area, serving as a field agency of the Army Service Forces in a specified area. Under the reorganization of the War Department on 9 Mar 42, there were nine geographical service commands throughout the United States, each providing services (including administrative, financial, legal, statistical, medical, welfare, etc., for Army elements), constructing facilities, furnishing fixed communication services, and procuring, storing, maintaining, and distributing supplies and equipment for Army use. See WD TM 20–205, Dictionary of United States Army Terms, 1944, p. 249.

[7] MDH, Bk. 1, Vol. 14, pp. 7.1–7.2, DASA; Groves, *Now It Can Be Told*, pp. 138–39; Marshall

Continued

By early 1943, the pace of the District's growth—both geographically and in terms of personnel—and its increasing security requirements emphasized the need for a more comprehensive counterintelligence program. In February, General Strong transferred Capts. Horace K. Calvert and Robert J. McLeod to the District headquarters, where they formed the District's new Intelligence Section. To ensure that this section, which Captain Calvert headed, had full access to the intelligence and security facilities of the Army service commands, Strong requested that each command designate a staff officer to act as a point of liaison with the Manhattan District and, to guarantee secrecy, authorized that each correspond directly with Calvert's section. At the same time, Groves continued his earlier practice of meeting with G-2 officers to make certain that District security problems were brought to the attention of appropriate Army officials.[8]

The counterintelligence program became the foundation for a countrywide permanent organization of this aspect of the District's security system. During the course of the year, the District organized its own Counterintelligence Corps (CIC) and, as its staff increased in size, assigned new personnel to those areas where there was the greatest concentration of project activities. Ultimately, the project had a total of eleven branch intelligence offices at key points across the United States, from New York to Pasadena (California). An officer assigned to a branch usually worked out of an area engineer's office and, in addition to his intelligence duties, served as security officer on the engineer's staff. While in matters of command these officers came under control of the Manhattan District intelligence and security officer and reported to him, they also maintained a direct liaison channel with the director of intelligence of the service command that had jurisdiction over their area.[9]

Expansion and Centralization

Rapid growth also necessitated expansion of other aspects of the Manhattan Project's security system. In 1942, the District's relatively modest internal security organization had served well enough for a program that consisted primarily of administering research and development activities carried on in university and industrial laboratories; but, by summer of 1943, a vast program of plant construction and operation had begun.

The move of the District headquarters from New York to Oak Ridge in August provided an opportune time for reorganization. (*See Chart 2.*) The first step was consolidation in July of the Protective Security and Intelligence Sections. Captain Calvert took over responsibility for the combined unit, designated the Intelligence and Security Section. Although this change was relatively minor from an administrative standpoint (the section continued in a distinctly subordinate position in the District's Service and

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Diary, 20 Jul 42, OCG Files, Gen Corresp, Groves Files, Misc Recs Sec, behind Fldr 5, MDR; Ltr, Lansdale to Col R. W. Argo, Jr. (Dep Chief of Mil Hist), 3 Jan 75, CMH.

[8] MDH, Bk. 1, Vol. 14, p. 7.2, DASA; Groves, *Now It Can Be Told*, pp. 138–39.

[9] MDH, Bk. 1, Vol. 14, pp. 7.2–7.4, DASA.

Control Division), it represented a significant shift towards centralization in security matters. This change was consistent with General Groves's conviction that only through a high degree of centralized control could he and his administrative staff maintain a close and constant scrutiny over the security program.[10]

Shortly after the District had completed its move to Oak Ridge, a reorganization in the Army's administration of counterintelligence operations in the zone of interior (ZI) posed a threat to Groves's control and cognizance over the project's internal security functions. To economize on internal investigative operations and to concentrate G–2 efforts on expanding counterintelligence operations overseas, the War Department directed the transfer, effective 1 January 1944, of the WDGS (War Department General Staff) G–2 counterintelligence activities in the ZI to the Office of the Provost Marshal General. The effect was to decentralize even further the Army's ZI counterintelligence functions to the service commands, including maintenance of data files on individuals which Manhattan intelligence officials considered essential to their operations. The change also seemed certain to enhance the difficulties the atomic project already was experiencing in coordinating its internal security operations with the service commands.[11]

From his vantage point as head of the atomic project's counterintelligence group inside G–2, Colonel Lansdale endeavored to have the group exempted from the reorganization requirements. When his efforts failed, General Groves decided that the only acceptable solution was to move Lansdale's unit into the Manhattan District. The G–2 sanctioned this change in December, and Lansdale secured authorization to establish a special counterintelligence detachment. Groves arranged for Lansdale's transfer to the Manhattan District; however, instead of placing him in charge of the new CIC Detachment, he brought Lansdale into his Washington office as his special assistant for security affairs. Lansdale's assignment was to keep the Manhattan chief abreast of problems and developments affecting internal security and foreign intelligence wherever they might arise in the project.[12]

The shift of all project counterintelligence activities to the District required major changes in its security organization. (*See Chart 3.*) The Intelligence and Security Section in February 1944 became a full-fledged division and, in keeping with Groves's

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[10] Org Charts, U.S Engrs Office, MD, 15 Aug and 1 Nov 43, Admin Files, Gen Corresp, 020 (MED-Org), MDR; Groves, *Now It Can Be Told*, p. 139.

[11] Ms, ASF, "Hist Intel Div," 1(9):10–11; Ms, Bernardo, "CIC Hist," pp. 14–15. Both in NARS. WD Cir 324, sub: Transfer of CI Functions Within the ZI, 14 Dec 43. Memos, CG OIG (Maj Gen Virgil L. Peterson) to Dep Chief of Staff (Lt Gen Joseph T. McNarney), sub: Intel Activities in Svc Cmds, 6 Nov 43, and Col O. L. Nelson (Asst to McNarney) to CG ASF and to ACS G–2, same sub, 25 Nov 43, reproduced in Monograph, Office of the Provost Marshal General, "The Loyalty Investigations Program," Tab 45, CMH (see also pp. 52–58 for details on the elimination of unnecessary investigations). Millett, *Army Service Forces*, pp. 358–59. Ltr, Strong to CG 4th Svc Cmd, sub: Personnel on DSM Proj, 27 Dec 43, reproduced in MDH, Bk. 1, Vol. 14, App. A2, DASA. Ibid., pp 7.5–7.7, DASA. WD Bur of Pub Rels, sub: Script for Radio Broadcasts, 12 Aug 45, Admin Files, Gen Corresp, 000.73 (Radio Broadcasts), MDR.

[12] Ltr, Lansdale to Argo, 3 Jan 75, CMH; Testimony of Lansdale in *Oppenheimer Hearing*, pp. 259–60.

centralization policy, moved from the Service and Control Division into the district engineer's own office. To replace Captain Calvert, whom Groves had selected for a special intelligence mission in London, Colonel Nichols—the district engineer since August 1943—brought in an experienced intelligence officer, Lt. Col. William B. Parsons, to head the new division. In this capacity Parsons administered the District's security program with the assistance of Major McLeod, the deputy, and Capt. Bernard W. Menke, the executive officer, and with support from a large operating staff of military and civilian personnel. Although Parsons officially reported to Nichols, he personally kept General Groves appraised of all developments.

Expanding intelligence and security activities necessitated procurement of additional personnel to carry out supportive security functions, such as plant inspections and technical and undercover investigations, Colonel Parsons drew 25 officers and 137 enlisted men from the War Department's counterintelligence manpower pool and the District's personnel specialists recruited a large number of civilians. In May 1944, to provide administrative services for the expanding security force, Nichols activated the 13th Special Engineer Detachment (Provisional) and assigned Parsons the additional duty of unit commander. Concerned about achieving greater efficiency in security operations, Parsons requested and received permission in January 1945 to combine the 13th with the CIC Detachment.[13]

By this time, Parsons' Intelligence and Security Division had become a highly centralized unit, organizationally divided into six separate branches: Clinton Engineer Works (CEW), Security, Administration, Safeguarding Military Information (SMI), Branch Offices, and Evaluation and Review. The CEW, Security, and Administration Branches, for which McLeod had direct responsibility, dealt primarily with security matters at the Tennessee site. The CEW Branch administered the local civilian guard force and the military police contingent that protected the Tennessee reservation; coordinated subordinate security offices in the K-25 (gaseous diffusion), Y-12 (electromagnetic), and X-10 (pile) process areas; and, through a board established for the purpose, reviewed security cases. The Security Branch chiefly monitored activities related to security of project manufacturing plants, especially at the Clinton site, and the shipping of classified materials and equipment. The Administration Branch was concerned primarily with personnel security problems, both military and civilian, but also provided facilities for the special handling of the division's mail and records and administered certain confidential funds.

The SMI, Branch Offices, and Evaluation and Review Branches, for which Captain Menke had direct responsibility, eventually evolved as a

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[13] Org Charts, U.S. Engrs Office, MD, 15 Feb 44, MDR; MDH, Bk. 1, Vol. 14, pp. 7.7-7.8, DASA; Memo, Strong to CG ASF, sub: CIC Detachment for MD, 18 Dec 43, reproduced in ibid., App. B3, DASA; Ltr, Col Donald E. Antes (Spec Insp for Fiscal Procedures) to Groves, sub: Investigation of Promotions, MD Intel Br, 13 Jul 45, Admin Files, Gen Corresp, 319.1 (Recs Insp: Hanford, 1945-46), MDR.

CHANGING OF THE GUARD: MILITARY POLICE CONTINGENT AT CEW

central clearinghouse for intelligence and security matters that related not only to the Tennessee site but also to the various project operations elsewhere. The principal responsibility of the SMI Branch was that of project-wide monitoring of programs in security education, censorship, and the handling of classified materials. The Branch Offices Branch, as its name would indicate, was responsible for coordinating field security operations in the eleven geographical areas where atomic energy activities were in progress and for reporting the area engineers' security problems to the division's Evaluation and Review Branch. The latter branch concentrated in one office functions hitherto performed by several of the branch intelligence offices—most notably, those concerned with the conduct of subversive investigations and the preparation of special reports on District security matters for higher echelons.[14]

Counterintelligence Activities

Counterintelligence activities constituted one of the most significant aspects of the District's security program. Through effective counterintelligence measures, the District sought to provide the shroud of secrecy necessary to forestall all attempts by the enemy not only to gain information about the American atomic energy program but also to sabotage it.

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[14] MDH, Bk. 1, Vol. 14, pp. 7.2-7.13 and App. A7 (Org Chart), DASA; Memo, Col Elmer E. Kirkpatrick, Jr. (Dep Dist Engr) to Groves, sub: Insp of Intel Div, Oak Ridge, 15 Dec 44, Admin Files, Gen Corresp, 319.1 (Insp of Intel Div), MDR.

Yet by its very nature, the Manhattan Project remained vulnerable to espionage and sabotage. The District's recruitment of thousands of individuals with almost every conceivable kind of background and from all parts of the country made likely the employment of some potential spies and saboteurs, no matter how efficient its clearance procedures might be, and its widely scattered installations made implementation and maintenance of uniform security procedures throughout the project very difficult. The reality of these conditions forced project leaders to assume that, sooner or later, Germany and Japan—and even the Soviet Union—would learn of the atomic energy program and, more importantly, use espionage to expand their knowledge of it and sabotage to destroy America's military advantage.[15]

To detect and counter potential espionage and sabotage activities, the District's CIC Detachment relied primarily upon extensive intelligence investigations. The majority of these investigations were of a preventive character, designed to minimize the likelihood that security might be breached. Of this type, for example, were the many security checks into the unauthorized transmission of classified information. In most instances, CIC personnel found that the information leaks thus uncovered were the result of carelessness or ignorance on the part of the employee or individual with knowledge of the project. But because it was always possible such leaks were surface ramifications of much more dangerous espionage activity, all cases of careless handling of classified data received prompt and rigorous corrective action.

A second type of preventive investigation was the supplementary and more thorough check into the background of employees earlier subjected to routine clearance procedures. Most supplementary investigations were made because preliminary data indicated an employee might be a potential security risk or routine procedures had not produced adequate information about the person's background. Typical cases were those involving scientists or technicians who recently had come from abroad, especially those who had come from areas under control of the Axis powers. Faced with a continuing shortage of scientifically and technically trained personnel, project leaders early had adopted the policy of weighing the degree of risk against the contributions an employee with security clearance problems could make in development of atomic weapons. "All procedures and decisions on security, including the clearance of personnel," Groves recalled, "had to be based on what was believed to be the overriding consideration—completion of the bomb. Speed of accomplishment was paramount." [16]

Perhaps the most notable example of the application of Groves's dictum on employing talented individuals who were security risks was the case of J. Robert Oppenheimer. When the Manhattan commander decided to appoint Oppenheimer as head of the Los Alamos Laboratory in February 1943, he did so with full knowledge that the theoretical physicist, who had worked on the project since late 1941, had only an interim security clearance from the OSRD. OSRD Director Vannevar Bush, S-1 Committee Chairman James B. Conant, and the other scientific leaders were generally aware of Oppenheimer's past record of association with Communist-related organizations and individuals. They knew that during the 1930's he had been attracted to a number of Communist-front organizations and, while never a member of the party itself, made fairly regular contributions to Communist-supported causes. Communist fellow-travelers, including his former fiancee, were among his friends, and his wife and brother and sister-in-law were former Communists. With the signing of the Nazi-Soviet pact in 1939, Oppenheimer had begun to have serious doubts about the Communists; however, he continued to contribute to the Spanish War Relief through party channels until the spring of 1942 and to maintain a casual contact with his former friends.[17]

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[15] Rpt to President, sub: Status of Tube Alloys Development, 9 Mar 42, Incl to Ltr, Bush to President, same date, MDR.

[16] Groves, *Now It Can Be Told*, pp. 141–42. See also MDH, Bk. 1, Vol. 14, pp. 2.1–2.2, DASA.

Despite his record of past Communist associations, Groves decided Oppenheimer was the best choice to direct the bomb laboratory at Los Alamos, for since 1941 he had been involved in this aspect of research and development under Metallurgical Laboratory Director Arthur Compton and in the summer of 1942 had become head of the project team concentrating on that work. Hardly had Oppenheimer arrived at Los Alamos in the spring of 1943 when the question of his clearance arose in a new form. At the request of the Manhattan commander, Lt. Col. Boris T. Pash, chief of the Counterintelligence Branch of the Western Defense Command, began an investigation of suspected Soviet espionage in the Radiation Laboratory at Berkeley. Several men known or thought to be associated with Oppenheimer came under suspicion and, as a result, so did Oppenheimer himself.[18] On 29 June, Pash submitted his conclusion that Oppenheimer "may still be connected with the Communist Party." He offered three possible courses: to replace Oppenheimer as soon as possible; to train a second-in-command at Los Alamos as a possible replacement; and, Pash's recommendation, to have Oppenheimer meet with Generals Groves and Strong in Washington so that they could brief him on "the Espionage Act and its ramifications" and also instruct him that the government was fully aware of his Communist "affiliations," that no "leakage of information" would be tolerated, and that the entire project would be held under "rigid control." In recommending this procedure,

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[17] Discussion of Oppenheimer security clearance based on *Oppenheimer Hearing*, especially testimony of Oppenheimer, Groves, Pash, and Bush; Memo, Groves to Secy War, sub: Loyalty Clearance of J. R. Oppenheimer, 24 Mar 47, Admin Files, Gen Corresp, 333.5 (Clearance Ltrs), MDR; Groves, Comments on Draft Ms "Now It Can Be Told," LRG; Interv, British writer Hailey with Groves, 13 Dec 57, LRG.

[18] See Rpt, MID, sub: Investigations of Federation of Architects, Engineers, Chemists, and Technicians, Local 25, 13 Aug 43, Incl to Memo, Groves to Bundy, 17 Aug 43, HB Files, Fldr 61, MDR.

Pash was of the opinion that Oppenheimer's "personal inclinations would be to protect his own future and reputation and the high degree of honor which would be his if his present work is successful, and, consequently, . . . that he would lend every effort to cooperating with the Government in any plan which would leave him in charge." In any event, he suggested, Oppenheimer should be told that two bodyguards were being assigned to protect him against violence from Axis agents. These bodyguards should be specially trained counterintelligence agents who would not only serve as bodyguards but also keep a check on Oppenheimer.[19]

Colonel Pash's report did not change Groves's opinion. After a quick visit to Los Alamos, during which he presumably discussed matters with Oppenheimer, Groves directed on 15 July that he be cleared. On his return to Washington a few days later, he directed "that clearance be issued for the employment of Julius Robert Oppenheimer without delay, irrespective of the information which you have concerning Mr. Oppenheimer. He is absolutely essential to the project."[20] As he wrote the Secretary of War four years later, "it was apparent to me that [Oppenheimer] would not be cleared by any agency whose sole responsibility was military security. Nevertheless, my careful study made me feel that, in spite of [his] record, he was fundamentally a loyal American citizen and that, in view of his potential overall value to the project, he should be employed."[21]

Most security cases investigated by the District's CIC Detachment involved breaches of classified information or allegations against employees handling classified work of disloyalty to the United States or of affiliation with organizations espousing subversive ideologies. While many such cases presented the possibility of espionage, in fact, investigations turned up only about one hundred instances of such activity. When suspected cases appeared on the increase in 1943, the Manhattan commander selected a number of the District's own CIC personnel to serve as special undercover agents. They occupied strategically located positions in project offices, laboratories, and plants, set up listening posts, checked intensively into personnel and other records of individuals under suspicion, and took other measures designed to solve espionage cases.[22]

The appointment of special agents was a move towards greater formalization of the procedure for dealing with espionage, which continued to increase as the project grew in size and scope. Another constructive measure was the establishment of a group of permanent surveillance squads to carry out supplemental and nonroutine personnel investigations. Members of these squads, as well as other District security agents, soon became adept in employing professional counterespionage techniques and in using such surveillance equipment as cameras with special lenses (telephoto and other types) and concealable listening and recording devices. During their investigations of persons suspected of espionage activities, either District employees or individuals who had contact with project personnel, the agents operated in the guise of diverse roles—to mention only a few, hotel clerks, bell captains, tourists, electricians, painters, contractors, and gamblers.

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[19] Memo, Pash to Lansdale, sub: J. R. Oppenheimer, 29 Jun 43, reproduced in *Oppenheimer Hearing*, pp. 821–22.

[20] Memo (source of quotation), Groves to Dist Engr, sub: J. R. Oppenheimer, 20 Jul 43, reproduced in *Oppenheimer Hearing*, p. 170; Groves Diary, 14–20 Jul 43, LRG.

[21] Memo, Groves to Secy War, sub: Loyalty Clearance of J. R. Oppenheimer, 24 Mar 47, MDR.

[22] Details on appointment of special agents and surveillance squads based on MDH, Bk. 1, Vol. 14, pp. 2.3–2.4, DASA; Ltr, Lansdale to Argo, 3 Jan 75, CMH; Groves, *Now It Can Be Told*, p. 139; MPC Rpt, 21 Aug 43, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab E, MDR. The section on Russian activities, which deals with espionage incidents at Berkeley, provides a good example of Groves's reports to the Top Policy Group on intelligence developments.

To ensure effective functioning and control of the surveillance squads and other special security agents on a countrywide basis, District security officials developed new channels of coordination and communication. Through Colonel Lansdale's counterintelligence staff at Groves's Washington headquarters, field security teams at the various branch intelligence offices had access to information from the FBI and other government security agencies. These field teams also had to file written reports of their findings and activities on a regular basis with the Evaluation and Review Branch of the Intelligence and Security Division. As these reports accumulated in the files at District headquarters, they became an important source of information for operation of the whole counterintelligence program. General Groves, in particular, made use of the data garnered from these reports in concert with information acquired from other government agencies in preparing his periodic Military Policy Committee and Top Policy Group briefings on intelligence developments affecting the atomic program.

Espionage Incidents

The most serious espionage activity came not from the enemy but from America's wartime ally: Soviet Russia. Having in the United States a large diplomatic and consular staff as well as other officials for overseeing lend-lease and other assistance programs, the Russians had a more than adequate reservoir of personnel for maintaining an extensive espionage apparatus in this country. Soviet agents, masking as diplomatic and consular officials, turned to members of the Communist Party of the United States and to party sympathizers for assistance in penetrating American wartime institutions and projects. The Russians, making the plea that the American government was withholding important information and thus unnecessarily delaying Allied victory, recruited many native Communists and fellow-travelers to assist them in obtaining vital secrets about wartime activities.[23]

As early as February 1943, counterintelligence agents of the FBI and Western Defense Command became aware that the Russians were obtaining data concerning activities of the Radiation Laboratory at the University of California. Further investigation revealed that, in October 1942, a leading member of the American Communist Party on the West Coast had advised a fellow party member employed at the Radiation Laboratory to retain his position so he could obtain knowledge of the secret work under way there. This employee and other Communists or Communist sympathizers working at the laboratory were passing on information about the atomic project at Berkeley to Communist Party members, who promptly turned it over to the Soviet vice consul in San Francisco. Evidence came to light in early April that a high official in the Soviet embassy in Washington had recently given money to a West Coast Communist leader, to be used for espionage. Intensive investigation by Western Defense Command counterintelligence agents resulted in prompt identification of those Radiation Laboratory employees who were engaging in espionage activities. The laboratory discharged the suspects and, where feasible, the Army inducted them into service, placing them in nonsensitive assignments in which they could be kept under regular observation.[24]

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[23] Ms, ASF, "Hist Intel Div," 1(7):8–10, NARS.

The District's CIC Detachment scarcely had completed breaking the original espionage chain at Berkeley when, in late August, Oppenheimer reported his suspicion that new leaks apparently had developed in the laboratory's security system. On the occasion of a visit to Berkeley, Oppenheimer met with Colonel Pash and told him he had learned that a member of the University of California staff, a man who had been a close friend, was acting as an intermediary for transmission of data from certain Radiation Laboratory employees to representatives of the Soviet Union. By Oppenheimer's account, his friend had been recruited by an official of the Federation of Architects, Engineers, Chemists, and Technicians, a CIO (Congress of Industrial Organizations) union currently trying to organize employees of the Radiation Laboratory. In subsequent questioning, Oppenheimer refused to disclose the name of his friend on the grounds that he was certain the friend was no longer passing information to Soviet representatives. Oppenheimer's uncooperativeness at this juncture resulted in the Manhattan commander taking personal action. Groves promptly met with the Los Alamos Laboratory chief and, because the security of the atomic project was at stake, ordered him to reveal the name of his friend. Faced with Groves's insistence in the matter, Oppenheimer named Haakon Chevalier, a professor of romance languages at the University of California. A short time later, the university dismissed Chevalier from his teaching post and he left Berkeley. In retrospect, the likelihood that Chevalier passed any classified information about the project to the United States seems remote.[25]

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[24] MPC Rpt, 21 Aug 43, MDR; MPC Min, 29 Dec 44, Exhibit F (summary of U.S.-based counterintelligence developments affecting Manhattan Proj), OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; Rpt, sub: Summary [of] Russian Situation, Incl to Memo, Groves to Secy State James F. Byrnes, 13 May 45, OCG Files, Gen Corresp, MP Files, Fldr 12, Tab D, MDR.

[25] In 1954, Oppenheimer testified before the AEC's Personnel Security Board, which was holding hearings to consider serious charges against the former director of the Los Alamos Laboratory that would lead ultimately to the withdrawal of his government security clearance. Oppenheimer admitted that he had fabricated the story about Chevalier's espionage activities; however, he never adequately

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The Chevalier case was not the final incident of espionage at the Radiation Laboratory. Less than a year later, another serious security leak had developed there. With assistance from Communist Party members living in the San Francisco area, a key scientist from the laboratory met with officials from the local Soviet consulate. The scientist passed on information concerning the pile process, certain chemical data, and the recently arrived British scientists. The District's CIC Detachment was able to end this espionage activity effectively by securing immediate discharge of the offending scientist, after which, as far as is known, representatives of the Soviet Union made no further attempts to get information from the Berkeley project.[26]

Meanwhile, probably acting on the basis of information gained at the Radiation Laboratory, the Russians had assigned one of their best men to the Chicago area, with the task of establishing an espionage channel at the Metallurgical Laboratory. By early 1944, this Soviet agent, who was a highly trained engineer with working experience in both Russian and American industry, had made contacts with several Metallurgical Laboratory employees. By the time the FBI learned of his activities in April, the Soviet agent had obtained considerable technical information, which he had passed on to the Russian consulate in New York. Once identified, the laboratory summarily dismissed the suspected employees. Subsequently, the District's CIC Detachment discovered that one of the discharged workers—a reserve officer who had been called to active duty and assigned to the Northwest Territory in Canada—had taken highly classified material with him when he left the Metallurgical Laboratory. Fortunately, District security officials were able to arrange for confiscation of this material (it was located in the officer's baggage) and for transfer of the officer to a post in the Pacific Theater of Operations where he would have no opportunity to pass on his knowledge to Russia or the Axis powers.[27]

Judged in terms of the ultimate utility of the information gained, Russian efforts at espionage at the Los Alamos Laboratory in late 1944 and early 1945—the crucial period of bomb development—were the most successful of the wartime period. But project counterintelligence agents did not learn of this activity until the late summer of 1945, after the war was over. In a sensational postwar trial, Julius and Ethel Rosenberg and Morton Sobell were convicted of stealing classified data from the laboratory

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explained why he had done so. Oppenheimer's testimony in 1954 and documents relating to it are in *Oppenheimer Hearing*, passim. For fuller accounts of the Oppenheimer case see Strauss, *Men and Decisions*, pp. 267–95, and Philip M. Stern, *The Oppenheimer Case: Security on Trial* (New York: Harper and Row, 1969). For further details on espionage activities at the Radiation Laboratory and the Oppenheimer case see MPC Rpt, 4 Feb 44, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab C, MDR; Rpt, sub: Summary [of] Russian Situation, Incl to Memo, Groves to Byrnes, 13 May 45, MDR; Interv, Author with Lt Col Peer de Silva (former CIC staff member, G–2, West Def Cmd, with special assignment to Rad Lab), 8 Apr 75, CMH; Diary of Lt Col E. H. Marsden (hereafter cited as Marsden Diary), 20 July 43, OROO. Marsden was the District's executive officer.

[26] MPC Min, 10 May 44, MDR; MPC Rpt, 7 Aug 44, MDR; Rpt, sub: Summary [of] Russian Situation, Incl to Memo, Groves to Byrnes, 13 May 45, MDR.

[27] Rpt, sub: Summary [of] Russian Situation, Incl to Memo, Groves to Byrnes, 13 May 45, MDR.

with the assistance of Mrs. Rosenberg's brother, David Greenglass, an Army sergeant at Los Alamos, and of transmitting it to Russian agents. Los Alamos, too, was the place where the German refugee scientist, Klaus Fuchs, while serving as a member of the British team sent to the United States under the interchange program, gained a substantial part of the technical knowledge of the bomb that he subsequently passed on to the Russians, first in June 1945 and thence periodically until his arrest by British authorities in early 1950.[28]

Project leaders also had anticipated that, as the Russians, the Axis powers—particularly Germany—would launch an equally vigorous espionage campaign, but they uncovered no evidence of such activity during the war. In early 1944, at a time when available Allied intelligence indicated that the Germans might well have attained an advanced stage in the development of atomic weapons, the Military Policy Committee reported to the Top Policy Group that "no espionage activities by the Axis nations with respect to this project have been discovered, although there have been suspicious indications."[29]

Measures Against Sabotage

In a project where the ultimate goal depended upon continuous progress in intricate and closely related production processes, unscheduled delays or interruptions of any kind could be disastrous. Sabotage in any form, whether perpetrated by outsiders or insiders bent upon slowing down or disrupting a particular process, constituted an ever-present hazard. Recognizing the seriousness of this threat, General Groves directed that any suspicion of sabotage be reported to him immediately. In keeping with Groves's policy of constant vigilance to detect any hint of sabotage, the District's CIC Detachment thoroughly investigated every instance of mechanical failure, equipment breakdown, fire, accident, or similar occurrence not readily attributable to normal causes, and kept under constant observation all processes and activities that might attract the efforts of saboteurs. In addition, other security personnel regularly inspected the security systems and personnel clearance procedures at the project's various installations, with the objective of detecting and correcting possible weaknesses that might invite sabotage.[30]

Illustrative of Groves's policy was the investigation into the mystifying failure of the first great magnets installed in the electromagnetic plant at the Clinton Engineer Works. Following a brief period of operation, the magnets began to malfunction. After disassembling one of the magnets piece by piece, Kellex engineers found that in its oil circulation and cooling system rust and dirt particles were bridging the gaps between the silver bands forming the coil component, which they attributed to the manufacturer's failure to maintain sufficiently rigid standards of cleanliness. The significance of this incident was that it revealed the inherent vulnerability of the electromagnetic installations and the need for constant surveillance in order to thwart possible sabotage.[31]

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[28] Postwar revelations of espionage activities at Los Alamos during World War II may be traced in Groves, *Now It Can Be Told*, pp. 143–45, and in Richard G. Hewlett and Francis Duncan, *Atomic Shield, 1947–1952*, A History of the United States Atomic Energy Commission, Vol. 2 (University Park, Pa.: Pennsylvania State University Press, 1969), pp. 312–14, 415, 472.

[29] MPC Rpt, 4 Feb 44, MDR.

[30] MDH, Bk. 1, Vol. 14, pp. 2.5–2.6, DASA. For a detailed discussion of typical measures undertaken to provide for the physical and personnel security of a specific project installation—in this instance, the gaseous diffusion project at Clinton—see MDH, Bk. 2, Vol. 1, "General Features," pp. 6.2–6.3, Vol. 2, "Research," pp. 9.2–9.4, Vol. 3, "Design," pp. 16.2–16.6, Vol. 4, "Construction," p. 4.2, and Vol. 5, "Operation," pp. 9.2–9.10, DASA.

The district's continuous and thorough efforts to protect the project's installations and operations against sabotage were signally successful. During the war years, there were no definitely established incidents of sabotage traceable to enemy agents. In most cases where breakdowns or other failures occurred under suspicious circumstances, investigations revealed they were probably the result of causes other than enemy sabotage. For example, during construction of the original gaseous diffusion plant at the Tennessee site, inspectors discovered someone had driven nails through the rubber coverings of vital electric cables leading underground from the power plant to the main production plant. The perpetrators of this act were never found, although the evidence indicated strongly it was the work of disgruntled employees.[32]

A quite different type of interference with plant operation briefly threatened the Hanford Engineer Works in early 1945. Groves reported to the Military Policy Committee in February that Army and Navy intelligence had recorded more than fifty incidents of Japanese balloons at various sites along the Pacific Coast, some of them carrying incendiary and fragmentation bombs. While none of these appears to have been directed specifically against the Hanford installations, on 10 March a balloon of this type struck a high-tension transmission line running between the Grand Coulee and Bonneville generating stations and caused an electrical surge through the interconnecting Hanford line that carried power to the production piles. Automatic safety devices at the three piles were activated, briefly shutting down their operation. Fortunately, the bombs attached to the balloon did not explode and the transmission line was not seriously damaged.[33]

Other Functions

One of the most unusual duties assigned to the District's CIC Detachment was that of furnishing bodyguards for key Manhattan scientific leaders. CIC personnel accompanied J. Robert Oppenheimer, Ernest Lawrence, Arthur Compton, and Enrico Fermi almost continuously. They accompanied other scientists at intervals, when they were at work on projects that required their special

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[31] Groves, *Now It Can Be Told*, pp. 104–05; MDH, Bk. 5, Vol. 3, "Design," p. 4.6, and Vol. 5, "Construction," pp. 3.10–3.11, DASA.

[32] Groves, *Now It Can Be Told*, pp. 112–13; Completion Rpt, M. W. Kellogg Co. and Kellex Corp., sub: K-25 Plant, Contract W-7405-eng-23, 31 Oct 45, p. 12, OROO.

[33] MPC Min, 24 Feb 45, MDR; Memo, Matthias to Groves, sub: 10 Mar 45 Power Outage, 29 Mar 45, Admin Files, Gen Corresp, 675, MDR; Matthias Diary, 25 Feb and 10–11 Mar 45, OROO.

protection. Colonel Marshall had originated the idea of bodyguards, suggesting that they serve also as drivers, to conceal their true function and to reduce the likelihood of accidents. Compton's bodyguard, a former Chicago policeman, traveled with him in the guise of a special assistant. When Compton was in residence at Oak Ridge, his guard served as a member of the local police force. District security officials exercised considerable care in selecting individuals for bodyguards, seeking those who had demonstrated ability to adapt themselves readily to the kind of situations in which scientists were likely to be involved.[34]

Safeguarding Military Information

Even though District security officials had planned and implemented a multi-faceted security system to protect all aspects of project operations and developments, they fully realized that maintenance of total secrecy in such a vast project was unlikely. What was more feasible, they believed, was to prevent leakage of any useful knowledge of the program's special scientific concepts, industrial techniques, and military objectives—or, in Army parlance, "safeguarding military information." [35]

Compartmentalization Policy

Under the provisions of Army security regulations, the basic responsibility for the protection of classified information rested upon "all military personnel, civilian employees of the War Department, and . . . the management and employees of all commercial firms engaged in classified work or projects for the War Department." [36] In applying this principle to the atomic program, District security officials placed particular emphasis upon limiting the amount of classified information permitted to any single individual or group of individuals. District security regulations established two basic rules which were to "govern the right to possess classified information"; a person must need the information in order to carry out his job and have access only to the amount of information "necessary for him to execute his function." To make doubly certain an individual employee was restricted to "the minimum necessary for the proper performance of his duties," District regulations further directed that "employees . . . shall be organized into small working groups or teams so far as possible, each working on its own phase of the job and not being permitted to inspect or discuss the work being done by others." [37]

This compartmentalization policy became a far more pervasive influence in the project after the Army as-

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[34] MDH, Bk. 1, Vol. 14, pp. 2.10–2.11, DASA; Marsden Diary, 20 Jul 43, OROO; Nichols, Comments on Draft Hist "Manhattan," Incl to Ltr, Nichols to Chief of Mil Hist, 25 Mar 74, CMH; Compton, *Atomic Quest*, pp. 183–84.

[35] AR 380–5, 28 Sep 42. The War Department issued a substantially revised version of AR 380–5 on 15 Mar 44, adding the category Top Secret to the previously existing categories Secret, Confidential, and Restricted. See Sec. 1, par. 3.

[36] Ibid., Sec. 1, par. 9.

[37] Quotations from MD, Intel Bull 5, Safeguarding Mil Info Regs, 27 Nov 43 (revised 1 Sep 44), Sec. 3, reproduced in MDH, Bk. 1, Vol. 14, App. B7, DASA.

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sumed full responsibility for its administration. Where the OSRD had applied compartmentalization primarily to research and development organizations, the Army incorporated it into virtually every type of activity undertaken by the project. Typical was the District's insistence that production plant blueprints be broken down and distributed in such a way as to reveal as little as possible to any one individual about the overall character of the project. Similarly, the District required that equipment orders to commercial firms specify that an item not be manufactured and assembled at the same location. And when the production plants reached the point of start-up operations, plant managers received instructions to split up orders for raw materials among a number of suppliers so that the purpose for which they were being used could not be readily ascertained.

While project leaders agreed that some compartmentalization of information was necessary, considerable difference of opinion prevailed on the extent of limiting scientific and technical interchange, both between sections functioning within a laboratory or plant and between the various interrelated installations of the project. Military administrators, in contrast to their civilian counterparts, favored the enforcement of stricter controls. These generally took the form of written agreements covering those organizations and installations that needed to exchange data. The agreements specified in detail how and what information could be interchanged. Inevitably occasions arose when developments required interchange of classified information not covered in agreements. In such instances, project leaders applied directly to the district engineer or to General Groves for special permission to exchange the data needed.[38]

One of the most important interchange arrangements formed occurred in June 1943, when General Groves met with Compton and Oppenheimer for the purpose of establishing "the principles which should govern the interchange of information between the Chicago [Metallurgical Laboratory] and Los Alamos projects. . . ." As a basic criterion determining what information should be interchanged, they set up the test that only data that would "benefit work at both Chicago and Los Alamos" should be exchanged. The agreement that resulted spelled out, in considerable detail, exactly what information could and could not be interchanged (the latter included those categories relating to production piles, military weapons, and the time schedules of various developments); designated by name those individuals at each installation who were qualified to carry on interchange; and outlined exact procedures of exchange—by formal reports, secret correspondence, or visits and conferences. On the most sensitive matters, or where there was serious doubt about interchange, the only channel of exchange was through a visit to the Chicago laboratory by either Oppenheimer or a specifically designated group leader. Although negotiators of the agreement must have been aware of the generally restrictive character of its provisions, they nevertheless emphasized that its major objective was "to maintain as rapid and effective interchange of information as possible." [39]

Compartmentalization of information probably aroused more adverse criticism—both from participants in the atomic program and from some of those who, in retrospect, have reviewed its history—than any other single aspect of the project's security system. Among the participants, the most vociferous critics were the scientists, accustomed to working in college and university laboratories where they could freely interchange the results of their work with scientific colleagues in all parts of the world. Project scientists, such as Leo Szilard, held that overcompartmentalization was a primary cause of extended delays in achievement of scientific and technical objectives of the program. Testifying before a committee of Congress after the war, he asserted, for example, that "compartmentalization of information was the cause for . . . failure to realize that light uranium [U–235] might be produced in quantities sufficient to make atomic bombs. . . . We could have had it eighteen months earlier. . . . We did not put two and two together because the two two's were in a different compartment. . . ." [40] On another occasion he contended also that compartmentalization was not really "too successful" because "significant matters gradually leak through anyway." [41]

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[38] Groves, *Now It Can Be Told*, pp. 80 and 140; Gowing, *Britain and Atomic Energy*, p. 150; Talk, Groves to Women's Patriotic Conf on Natl Def (25–27 Jan 46), sub: "The Atomic Bomb," Admin Files, Gen Corresp, 337 (Women's Patriotic Conf on Natl Def), MDR; Memo, Marshall to Only Those Concerned, sub: DSM Proj–Clinton Engr Works, 18 May 43, OCG Files, Gen Corresp, MP Files, Fldr 28, Tab A, MDR; MDH, Bk. 1, Vol. 14, pp. 6.3–6.4, DASA.

[39] Memo, Groves to Compton and Oppenheimer, sub: Interchange of Info Between Chicago and Los Alamos, 17 Jun 43, Admin Files, Gen Corresp, 201 (Tolman), MDR.

Joining Szilard in condemning compartmentalization in the strongest possible terms was Edward U. Condon, the prominent American physicist who had come to the atomic project from the Westinghouse Research Laboratories. In fact, after spending only a month at Los Alamos, Condon came to the conclusion that he would be of more use to the war effort at Westinghouse than at the New Mexico laboratory. The project's security policy, he asserted, had a morbidly depressing effect on him. "I feel so strongly," he continued, "that this policy puts you in the position of trying to do an extremely difficult job with three hands tied behind your back that I cannot accept the view that such internal compartmentalization . . . is proper." [42]

Most other contemporary critics took a somewhat less extreme position. Concerned about insufficient interchange of data among atomic project scientists causing delays in the solutions of problems related to bomb development, Compton suggested to the OSRD S-1 Committee in December 1942 that it might be wise to increase the number of "responsible persons who are free of compartmentalization. . . ." [43] Similarly, in June 1943, physicist Richard C. Tolman, in his role as Groves's scientific adviser, expressed concern that the "proposed regulations [to govern interchange between the Chicago and Los Alamos scientists were] perhaps not quite as liberal as may later prove warranted." In the weeks following the institution of these regulations, both Oppenheimer and Edward Teller, who was working on a part-time basis at Los Alamos, were troubled by what they viewed as inadequate liaison channels between the New Mexico laboratory and the other installations where related work was in progress.[44]

When British officials and scientists came to the United States in late 1942, they were surprised to learn that General Groves planned further compartmentalization, which many of them viewed as already having been applied to an extent that made efficient operation impossible. Furthermore, the British soon found that the Americans used the policy as a convenient excuse for withholding information. Thus, the policy became intermeshed with the whole question of interchange with the British, a problem that was resolved only after many months of negotiation.[45]

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[40] Excerpts from Szilard's statements before Senate Special Committee on Atomic Energy given in Memo, Nichols to Groves, 12 Jan 46, Admin Files, Gen Corresp, 201 (Szilard), MDR.

[41] Memo for File, William S. Shurcliff, sub: Transcript of Notes Taken on 8-11 Oct 44 Trip to Chicago, 14 Oct 44, Admin Files, Gen Corresp, 001 (Mtgs), MDR. Shurcliff, a liaison official with the OSRD, talked to Szilard about security measures and recorded his comments in this memorandum.

[42] Ltr, Condon to Oppenheimer, 26 Apr 43, Investigation Files, Gen Corresp, Personnel Scty Investigations (Condon), MDR.

[43] Ltr, Compton to Conant, 8 Dec 42, Admin Files, Gen Corresp, 319.1, MDR.

[44] Ltr, Tolman to Groves, 11 Jun 43, Admin Files, Gen Corresp, 000.71 (Releasing Info), MDR. See also Ltr, Teller to Urey, Incl to Memo, Nichols to Groves, 11 Aug 43, and Ltr, Oppenheimer to Groves, sub: Liaison With Site X, 4 Oct 43, Admin Files, Gen Corresp, 001, MDR.

[45] Gowing, *Britain and Atomic Energy*, pp. 150-51. See Ch. X.

By early 1944, most project personnel had come to accept the policy as a fact of life. In looking back after the war was over, even some scientists who had found compartmentalization so distasteful grudgingly conceded it had probably been necessary. The eminent American (German-born) physicist James Franck, for example, while speaking at a conference on atomic energy at the University of Chicago in September 1945, concluded that "so far as secrecy is concerned, they [Army officers] were unrelenting and, in all honesty, we have to admit that they had to be." But, he went on to remind his listeners that the policy had exacted a "stiff price" in the "wasting of talent and scientific manpower and the loss of precious time. . . ." [46]

From the military point of view, compartmentalization was precisely what was required, both for security and for achieving the most efficient functioning of scientists and technologists. As General Groves expressed his conviction in retrospect:

> Compartmentalization of knowledge, to me, was the very heart of security. My rule was simple and not capable of misinterpretation—each man should know everything he needed to know to do his job and nothing else. Adherence to this rule not only provided an adequate measure of security, but it greatly improved overall efficiency by making our people stick to their knitting. And it made quite clear to all concerned that the project existed to produce a specific end product—not to enable individuals to satisfy their curiosity and to increase their scientific knowledge. [47]

Policy Exception: Informing Congress

The District's policy of compartmentalization of information on the atomic project, in Groves's words, applied "to everyone, including members of the Executive Department, military personnel and members of Congress." No one was to have access "solely by virtue of his commission or official position." Adherence to this policy was possible as long as Manhattan's funding came from sources already earmarked for the War Department. But project leaders anticipated considerable trouble in the future, because securing new funds would entail congressional authorization. [48]

By early 1944, the compartmentalization policy was becoming less and less feasible with Congress because of the increasing size of the program, its rapidly rising cost, and the need to begin planning for its postwar administration. Under the original directive from the President, the atomic program obtained funds from the money appropriated under the Engineer Service–Army budgetary category. Funds from this source sufficed as long as Manhattan's budgets remained relatively modest. But when project leaders estimated that the program would need at least $600 million for fiscal year (FY) 1945, they decided they would have to find a way to provide some information to selected members of Congress who had a need to know. They consulted with President Roosevelt, who thereupon directed that Stimson, Bush, and General Marshall brief the leaders of both parties in the House and the Senate.[49]

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[46] As quoted by Alice Kimball Smith in *A Peril and a Hope: The Scientists' Movement in America, 1945–47* (Chicago: University of Chicago Press, 1965), p. 95.

[47] Groves, *Now It Can Be Told*, p. 140.

[48] Ibid. (source of first quotation), p. 360; MD, Intel Bull 5, Safeguarding Mil Info Regs (source of second quotation), 27 Nov 43 (revised 1 Sep 44), Sec. 3, DASA.

On 18 February, Stimson, Bush, and Marshall went to the office of Speaker of the House Sam Rayburn, where they were joined by Majority Leader John W. McCormack and Minority Leader Joseph W. Martin, Jr. Stimson outlined the history of the atomic project, including its cost to date, and estimated the total amount needed to complete it; Bush described the project's scientific background and indicated the likely destructive power of an atomic weapon; and Marshall discussed the potential role of atomic bombs in the Allied strategy for winning the war. The legislators pledged their unreserved support, stating that they viewed its high cost as well worth the price. They promised to work out a system for handling the Manhattan appropriations in committee so that there would be no danger of disclosure of their purpose. Bush found that the "entire meeting was most reassuring, as it was quite evident the three congressmen were exceedingly anxious to be of aid to the War Department in carrying a very heavy responsibility."[50]

In June, Stimson, Bush, and Maj. Gen. George J. Richards, the War Department budget officer who was substituting for Marshall while he was out of town, repeated the briefing for the leaders of the Senate. Present were Majority Leader Alben W. Barkley and Minority Leader Wallace H. White, as well as Chairman Elmer Thomas and Senior Minority Member Styles Bridges of the military subcommittee of the Senate Appropriations Committee. Stimson recalled that "the four gentlemen who met with us were very much impressed. They . . . promised that they would help and keep absolute silence about it and prevent discussion in public as to what it was about."[51]

During the remaining months of 1944, congressional leaders succeeded in keeping the vast majority of the members of Congress ignorant of the atomic project. Accustomed to wartime restrictions, most members were willing to accept—without protest—the assurance of their leaders that the work was secret and that the needed apropriations were essential to the war effort. But for a few members this policy was unacceptable, and they directed individual inquiries to the War Department about rumored developments at the atomic sites.

A case in point was Congressman Albert J. Engel of Michigan, a member of the House Appropriations Committee, who in February 1945 was unwilling to accept automatically the War Department's request for FY 1946 funding from money appropriated under the Expediting Production budgetary category. In a visit to Under Secretary Patterson on the twenty-fourth, the Michigan representative stated that he had heard rumors of extravagance and waste and that he wanted more information before approving the War Department's FY 1946 funds. Remembering that in late 1943 War Department officials had dissuaded him from making a proposed trip to the Clinton site, this time he firmly insisted that Patterson allow him to inspect the atomic installations. When Stimson heard from Patterson of Engel's insistence upon visiting project facilities, he sought assistance from the leaders of the House of Representatives. As Speaker Rayburn was away, Stimson turned to Congressman John Taber of New York, another member of the Appropriations Committee. He and Taber sat down with Engel and persuaded him to forgo objections to funds on the floor of the House, but only after promising him an opportunity to visit some "outside installations" of the project.[52]

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[49] MDH, Bk. 1, Vol. 4, "Auxiliary Activities," Ch. 1, pp. 2.4–2.5, DASA. Groves, *Now It Can Be Told*, pp. 360–62; Stimson Diary, 14–15 Feb 44, HLS.

[50] Memo, Bush to Bundy, 24 Feb 44, OCG Files, Gen Corresp, MP Files, Fldr 14, Tab A, MDR; Stimson Diary, 18 Feb 44, HLS.

[51] Stimson Diary (source of quotation), 10 Jun 44, HLS; Memo for File, Bush, 10 Jun 44, OCG Files, Gen Corresp, MP Files, Fldr 14, Tab A, MDR; MDH, Bk. 1, Vol. 4, Ch. 1, pp. 2.8–2.11, DASA.

This experience convinced the Secretary of War and the Manhattan commander, as well as other project leaders, that more and more members of Congress would be demanding current information about Manhattan's activities. Consequently, they arranged to have a selected delegation from each House visit Clinton and, if they wished, also Hanford. With the President's approval for this plan, Groves and Stimson, accompanied by the Secretary's aide, Col. William H. Kyle, visited Clinton on 10 April to prepare "for future trouble with Congressmen."[53]

Upon the unexpected death of Roosevelt on the twelfth, the inspection trip to Clinton was delayed, but only temporarily. In May after President Truman had given his assent, Speaker Rayburn helped select five members from the House Appropriations Committee—Clarence Cannon, the chairman, George H. Mahon, J. Buell Snyder, Engel, and Taber. Under the careful guidance of the Manhattan commander and the district engineer, the five congressmen spent two days inspecting the Clinton Engineer Works. The legislators returned to Washington convinced that public funds had been well spent and prepared to support the project's budgetary requests for FY 1946. A visit by a comparable Senate delegation to inspect atomic facilities was not feasible until after V–J Day, when a group from the upper house toured the Hanford Engineer Works.[54]

Administrative Aspects

As security requirements increased, the Army established a variety of units to administer its highly compartmentalized information security program. By necessity, the program from about late 1942 up until the District's major intelligence and security reorganization in early 1944 was limited in scope. Faced with a rapid influx of new personnel, both civilian and military, the District's Protective Security Section concentrated chiefly on developing ways for instructing them in the meaning of classified information and the correct methods for handling it. To facilitate this education process, the small staff hurriedly prepared and distributed a manual that provided a "statement of District policy regarding Protective Security procedures . . . ," including an extensive section on safeguarding classified information.[55]

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[52] Stimson Diary, 26 (source of quoted words) and 28 Feb 45, HLS; Groves, *Now It Can Be Told*, p. 363; MDH, Bk. 1, Vol. 4, Ch. 1, pp. 2.5–2.6, DASA.

[53] Stimson Diary, 31 Mar 45, HLS.

[54] Ibid., 15 Mar, 2, 6–11, and 25 Apr, 4 and 30 May 45, HLS. Groves Diary, 22–24 May 45, LRG. Notes on Trip to Knoxville, Tenn., 10 Apr 45, Incl to Memo, Kyle to Bundy, 11 Apr 45; Ltrs, Stimson to Bush, 31 Mar 45, and Bush to Stimson, 2 Apr 45. All in HB Files, Fldr 7, MDR. MDH, Bk. 1, Vol. 4, Ch. 1, pp. 2.12–2.13, DASA. Groves, *Now It Can Be Told*, pp. 363–65. Hewlett and Anderson, *New World*, pp. 302 and 339–40.

An intensification of protective measures during the first half of 1943 resulted in the establishment in August of the Plant Security Section for Safeguarding Military Information. In an effort to assure attainment of the desired security objectives, the SMI staff developed a new intelligence bulletin. This bulletin, issued in November, set forth in detail the requirements and procedures for safeguarding military information, emphasizing that "matters of vital importance to the government must be protected at all times whether at war or at peace . . . [and thus] great caution [must] be exercised in the handling and in the dissemination of *all* information—written or oral—relative to this Project at any time."[56]

By early 1944, consolidation of the District's intelligence and security facilities opened the way for a more comprehensive information security program, and the establishment in May of a separate SMI Section (redesignated SMI Branch in 1945, when organizationally restructured as a subordinate unit of the District's Intelligence and Security Division). Under the expanded program, security officials launched studies of all aspects of the atomic project—equipment, material, products, processes, operations, administrative matters—to determine the appropriate classification for their mention in correspondence and other documents. They set up code names (some already in use) for major sites, important materials, items of equipment, and even for the more widely known scientists working on the project. Under this scheme, for example, Los Alamos became Site Y, plutonium became 94, the implosion bomb became Fat Man, and scientist Arthur H. Compton became A. H. Comas. Using the staff and resources of the SMI Section, District authorities directed attention to those areas where security leaks were most likely to occur. Thus, the section regularly reviewed project correspondence with other government agencies, such as the Selective Service concerning deferment of key personnel, and advised on the security classification that should govern each of the thousands of contracts that the District negotiated with outside individuals and firms.[57]

The establishment and maintenance of effective adherence to security requirements among the project's thousands of contractor organizations comprised one of the most challenging and complex aspects of the information security program. District authorities oversaw contractors' security activities through several channels. The branch intelligence offices in principal cities throughout the United States provided a convenient point of contact, and periodic checks of contractor facilities and operations by security inspectors from District headquarters constituted a second avenue of control. These inspectors particularly observed methods of handling classified materials and storing documents. District security officials also investigated contractors' personnel recruitment programs, written correspondence, stock registration statements to the Securities and Exchange Commission, and similar activities in which security leaks were likely to occur. Finally, when a contractor terminated his contract with the atomic program, District security officials made certain that all classified materials were returned to project control or that the contractor provided for their adequate protection.[58]

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[55] WD, U.S. Engrs Office, MD, Protective Scty Manual, 1 Feb 43, reproduced in MDH, Bk. 1, Vol. 14, App. C5, DASA.

[56] MD, Intel Bull 5, Safeguarding Mil Info Regs, 27 Nov 43 (revised 1 Sep 44), Sec. 3, DASA.

[57] MDH, Bk. 1, Vol. 14, pp. 6.3–6.5, DASA; Memo, Marshall to Only Those Concerned, sub: DSM Proj–Clinton Engr Works, 18 May 43, MDR; Ltr. Oppenheimer to Groves, sub: [Use of Cover Names], 2 Nov 43, Admin Files, Gen Corresp. 680.2 (Visits), MDR; Compton, *Atomic Quest*, p. 182.

Security problems involving firms under contract most frequently arose where these organizations were carrying out large-scale development of project facilities. Such development, as at the Clinton and Hanford sites, inevitably brought overcrowding of local housing, acute labor shortages, greatly increased road traffic, and other adverse changes that placed a severe strain on normal community activities. The resulting public resentment, generally focused on the contractor firms, created an environment in which threats to security were more likely to occur. In the spring of 1943, for example, Du Pont's effort to arrange for housing and other facilities for the thousands of employees who would work on the Hanford project stirred up resentment in surrounding communities, already aroused by the Army's land acquisition program. The spread of rumors, adverse criticism in the local newspapers, and unfounded statements by local officials tended to draw widespread public attention to the project, posing a serious threat to security. Lt. Col. Franklin T. Matthias, the Hanford area engineer, and members of his staff spoke at meetings of service clubs in communities adjacent to the project, in an endeavor to counter the rumors and misinformation concerning Du Pont's role in the project. By these and similar efforts they laid the groundwork for obtaining the support and good will of the local citizenry—an absolute essential to maintaining the security of the project.[59]

Efforts to maintain good community relations was an important aspect of the District's information security program, which had as its prime objective the forestalling of security breaks, first by anticipating them and second by teaching project personnel how to be "instinctively alert-minded and security-wise."[60] Although the SMI Section had primary responsibility for carrying out the program, employee education in security matters devolved chiefly to the SMI staffs at the branch intelligence offices. Each staff, for example, conducted orientation and refresher sessions for Corps of Engineers personnel; provided each contractor with instructional materials for in-house security education briefings for its personnel; and used a variety of media—training films, circulars and handbills, payroll inserts, telephone stickers, and editorials in project newspapers—to remind District employees of the importance of unremitting attention to the demands of security.[61]

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[58] MDH, Bk. 1, Vol. 14, pp. 6.7–6.8, DASA.

[59] Memo, Matthias to Groves, sub: Public Mtgs in Which Du Pont Participated, 23 Apr 43, Admin Files, Gen Corresp, 001 (Mtgs), MDR; Matthias Diary, 20 and 28 Apr 43, OROO.

[60] MD, Intel Bull 3, Scty Educational Prgm, 15 Sep 43, reproduced in MDH, Bk. 1, Vol. 14, App. B8, DASA.

Because of the policy of compartmentalization, the quantity and variety of educational subject matter available for training purposes was limited. Most workers had knowledge of only the project activity under way at the site where they were employed, and most generally did not even know exactly what was being made in the facility where they worked. And even in some instances, project officials had concocted for employees—those working at the electromagnetic plant—a plausible but inaccurate and misleading explanation of the process involved and the product produced, with the warning that this information was given to them only to help them carry out their jobs. Lacking concrete data on which to base an appeal to employees, security officials had to request that they accept the necessity for strict adherence to secrecy largely on faith and out of a sense of patriotism and loyalty to the men on the fighting fronts.

As did most wartime agencies involved in secret work, the Manhattan District resorted to censorship of various kinds as a means of safeguarding classified information. In the first few months after the Army assumed responsibility for the atomic program, the District and branch security staffs began a cursory review of a few leading daily newspapers and periodicals and gradually enlarged this check of publications until it covered some 370 newspapers and 70 magazines. The censors, several of whom were Women's Army Corps members, were particularly on the lookout for publication of anything that would reveal classified information, attract attention to the project, or furnish an enemy agent or anyone else with knowledge sufficient to determine the nature of the project.[62]

While review of newspapers, periodicals, and other publications provided some protection against damaging revelations about the project, the fact remained that once such information appeared in print an element of secrecy was lost. Much more effective was a system that prevented publication of sensitive information. Under the Office of Censorship's "Codes of Wartime Practices for the American Press and American Broadcasters," newspapers, periodicals, and radio broadcasters voluntarily agreed to refrain from discussing certain specified subjects and mentioning certain terms. In February 1943, Vannevar Bush proposed that the atomic energy program be brought under this voluntary censorship. At first, both General Strong, the Army intelligence chief, and General Groves had serious reservations about making the atomic energy project subject to this censorship arrangement, fearing that the results "might be more detrimental than otherwise."[63]

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[61] Ibid., pp. 6.10–6.11, DASA.

[62] Ibid., pp. 6.12–6.15, and Bk. 5, Vol. 6, "Operation," p. 6.1 and App. B1, DASA; Groves, *Now It Can Be Told*, p. 146.

Finally, military leaders reluctantly agreed to the voluntary press censorship plan, persuaded primarily by the insistence of Nathaniel R. Howard, assistant director of the Office of Censorship and a former editor of the *Cleveland News,* that this was the only way to maintain press security of the project. On 28 June 1943, Byron Price, director of the Office of Censorship, sent out a special request to all editors and broadcasters that they extend the previously issued precaution not to publish or broadcast anything about "new or secret military weapons . . . [or] experiments" to include:

> Production or utilization of atom smashing, atomic energy, atomic fission, atomic splitting, or any of their equivalents.
>
> The use for military purposes of radium or radioactive materials, heavy water, high voltage discharge equipment, cyclotrons.
>
> The following elements or any of their compounds: polonium, uranium, ytterbium, hafnium, protoactinium, radium, thorium, deuterium.[64]

The aim of censorship was to prevent all mention of the atomic program in the American press; however, on the advice of the Office of Censorship, the District permitted a limited amount of information about certain aspects of the project to appear in newspapers published in communities near the Clinton and Hanford sites. Office of Censorship officials pointed out that complete suppression of information about activities at these locations would actually draw more attention than a policy of judicious release of news of local interest, carefully controlled so as not to reveal any vital secrets. They cited as an example the land acquisition at Hanford, which required relocation of many people and resulted in court proceedings. Stories on these events in newspapers of the Washington-Oregon region would not violate essential security as long as they did not reveal the purpose of the acquisition or the interconnection of the Hanford project with other parts of the atomic program. General Groves assented to this policy but took the added precaution, suggested by Office of Censorship officials, of having Manhattan District representatives visit the editors or publishers of local newspapers and operators of local radio stations to request their cooperation in maintaining the security of the project.[65]

At Los Alamos, security authorities endeavored to keep all mention of the site and its activities out of the press. Total exclusion was more feasible at the New Mexico installation because of its military administration and geographic isolation from surrounding communities. The policy was reinforced in late 1943 through the use of regular mail censorship and other measures to minimize the likelihood that knowledge of the site would come to the attention of the press.[66]

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[63] Strong's reaction to the proposal during a discussion with General Styer, who later reported the discussion to Groves in Memo, Styer to Groves, 18 Feb 43, AG 313.3 (22 Aug 47), copy in CMH. See also Memo, Bush to Styer, 13 Feb 43, Admin Files, Gen Corresp, 000.73 (Censorship), MDR; Groves, *Now It Can Be Told,* p. 146.

[64] Price, sub: Note to Editors and Broadcasters—Confidential—Not for Publication, 28 Jun 43, Incl to Ltr, Howard to Groves, 28 Jun 43, Admin Files, Gen Corresp, 000.73 (Censorship), MDR. See also Groves, *Now It Can Be Told,* p. 146; MPC Min, 24 Jun 43, MDR.

[65] Ltr, Howard to Lt Col Whitney Ashbridge (Asst, Opns Br, Constr Div, OCE), 1 Apr 43, Admin Files, Gen Corresp, 000.73 (Censorship), MDR; Groves, *Now It Can Be Told,* pp. 146–47.

It was inevitable that a voluntary censorship system would not be totally effective, and on those occasions when some reference to the project or atomic energy occurred in the press or on the radio, the District security office and the Office of Censorship took immediate steps to limit its circulation and to run down it origins. A rash of censorship violations occurred in late 1943. A columnist in the *Washington Post* announced that the Senate's Truman Committee was about to investigate a "half-a-billion dollar" War Department project in the state of Washington that was "reported to be one of the largest single projects that's to be built from scratch in the Nation's history." On the same day the *Post* article appeared in the Spokane *Spokesman-Review*, and soon thereafter the wire services picked up the news item. Almost simultaneously, several newspapers in Tennessee ran a story on the state's Selective Service that contained a passing reference by the head of the service, Brig. Gen. Thomas A. Frazier, to "the Clinton Engineer Works in secret war production of a weapon that possibly might be the one to end the war." In both instances, prompt action by the Office of Censorship led to withdrawal of the articles before they had received wide circulation. Subsequent action by the War Department resulted in tracing down the sources of the leaks and in implementing improved security measures to prevent such occurrences in the future.[67]

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[66] Ltr, Groves to Oppenheimer, 1 Nov 43; Ltr, Capt Peer de Silva (Santa Fe Area Intel Off) to Lansdale, sub: Censorship at Los Alamos, 8 Nov 43; Memo, Lansdale to Groves, same sub, 10 Nov 43. All in Admin Files, Gen Corresp, 311.7 (Santa Fe), MDR. Groves, *Now It Can Be Told*, p. 147.

[67] Memo (source of first quotation), Groves to Secy War, sub: Publicity Concerning DSM Proj, 15 Dec 43; Memo (source of second quotation), Groves to Secy War, sub: Violation of Vital Scty Provs by Brig Gen Thomas A. Frazier, 10 Jan 44, and Incl; Rpt, Lansdale, sub: Publicity Concerning Clinton Engr Works, 3 Jan 44. All in HB Files, Fldr 62, MDR. References to atomic energy and the atomic project—some intentional, some accidental—occurred many times in the public media during the war. Examples of those investigated by Manhattan District security officials may be found in HB Files, Fldr 7, MDR, and in Admin Files, Gen Corresp, 000.73 (Censorship), MDR.

CHAPTER XII

Foreign Intelligence Operations

The Manhattan Project's security system involved the conduct of not only domestic but also foreign intelligence operations, for in terms of military strategy gaining all possible information about atomic activities in the Axis nations—especially Germany—was as important as safeguarding state-of-the-art information on American nuclear research and developments. Hitler's recurring claims that Germany had devised secret weapons, as well as existing intelligence reports on both German interest in the nuclear research of French physicist Frederic Joliot-Curie and German production of heavy water at the Rjukan (Norway) plant, convinced project administrators of the likelihood that Germany had under way a well-developed atomic energy program. In order to carry out necessary countermeasures against these presumed enemy efforts to produce atomic weapons, Allied military leaders in 1943 and 1944 intensified their foreign intelligence operations in the European Theater of Operations (ETO), giving a high priority to securing more information about enemy atomic activities. Manhattan Project officials initiated much of this intelligence effort, but eventually the War Department General Staff, General Marshall, Secretary Stimson, and number of other military leaders contributed directly to its success.[1]

Organization of the ALSOS Mission

Upon receipt of any intelligence information on atomic developments in enemy nations, the Army G–2, the Office of Naval Intelligence, and the Office of Strategic Services, as well as other existing intelligence agencies, dispatched a current intelligence report to the Manhattan District for the attention of General Groves. Until the fall of 1943, this reporting system had served to keep the Manhattan commander and other project leaders apprised of at least the accessible areas of enemy atomic activities. But in September, after the Fifth Army had landed in southern Italy, Groves perceived a unique opportunity for the Army to exploit new sources of information, especially about the German atomic program, as U.S. forces moved up the Italian peninsula. With the firm support of OSRD Director Vannevar Bush, Groves met with Maj. Gen. George V. Strong, the Army G–2, to explore ways of achieving this objective. The proposed course of action, with which Bush concurred, was the establishment of a special intelligence mission in Italy.

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[1] MPC Min, 13 Aug 43, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR.

Shortly thereafter, Strong met with General Marshall and suggested that a small group of civilian scientists, assisted by military personnel, be sent to Italy to conduct inquiries into scientific projects in that country, with the hope that they might reveal something about German developments. Marshall promptly approved the plan and asked Groves to take responsibility for foreign intelligence related to atomic energy. Apparently the Chief of Staff was convinced that Manhattan Project personnel and direction would result in better coordination, coverage, and less risk to security.[2]

Manhattan, OSRD, Army G–2, and the Navy all furnished personnel for the newly designated Alsos mission,[3] which completed its organization by late fall of 1943. As chief of Alsos General Strong appointed Lt. Col. Boris T. Pash, an intelligence officer whose earlier competence in the Manhattan District's espionage investigations at the Radiation Laboratory had impressed Groves. When the new mission reached Italy in late December, it had fourteen members, including Pash, an administrative officer, four scientists—two OSRD, one Army, one Navy—four interpreters, and four attached counterintelligence agents. Opening the Alsos field headquarters near Naples on the seventeenth, Pash established liaison with the Fifth Army Intelligence Section and representatives of Marshal Pietro Badoglio's Italian civil government.

ALSOS Operations in Italy

Alsos teams in the early weeks of 1944 interviewed Italian scientists and examined captured technical documents in Naples, Taranto, and Brindisi, and elsewhere in the zone of occupation.[4] They soon realized that little data on scientific developments in Germany and northern Italy was available in southern Italy, but discovered that Rome held more promise. To gain access to the Italian capital, Alsos officials prepared two alternate plans: the first, have Alsos personnel enter Rome with the Fifth Army as soon as the city fell; the second, bring Italian scientists out of Rome and northern Italy even before this occurred. Neither plan succeeded, however, because of the unexpectedly slow advance of the Allies. Alsos teams also had little success securing information from Italian scientists behind enemy lines, and by March most team members had returned to the United States.

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[2] Groves, *Now It Can Be Told*, pp. 185 and 189–90; Ms, Col Bruce W. Bidwell, "History of the Military Intelligence Division, Department of the Army General Staff" (Washington, D.C.: Department of the Army, n.d.), Pt. 5, p. 5.25, copy in NARS.

[3] Inadvertently, the letters of the code name Alsos form the Greek word meaning "grove." General Groves's first reaction, when a scholarly colleague informed him of the meaning of the word, was to request the G–2 to adopt a more innocuous name. After further consideration, however, he decided against making the change because he feared that to do so would create an even greater security hazard because of the attention it would draw to the mission. See Groves, *Now It Can Be Told*, p. 191.

[4] Except as otherwise indicated, section based on Ms, Bidwell, "Hist Mil Intel Div," Pt. 5, pp. 6.25–6.26, NARS; MDH, Bk. 1. Vol. 14, "Intelligence and Security," Foreign Intel Supp. 1, pp. 1.1–3.6, DASA; Groves, *Now It Can Be Told*, pp. 190–94; Lincoln R. Thiesmeyer and John E. Burchard, *Combat Scientists*, Science in World War II (Boston: Little, Brown and Co., 1947), pp. 164–65; Boris T. Pash, *The ALSOS Mission* (New York: Award House, 1969).

From the information secured in southern Italy, ALSOS scientists concluded that the Germans were carrying on little, if any, experimental activity with atomic energy. From their reports Groves estimated that the German program was at about the same stage the American program had been when the Army assumed responsibility for its further development. But the evidence was not sufficient. For this reason and with an eye to the coming invasion of Western Europe, ALSOS scientists recommended that measures be undertaken to secure knowledge of scientific developments in new theaters of operation.[5]

When Colonel Pash, who was in London preparing the ALSOS mission to accompany the invasion of Western Europe, received word that Allied troops had entered Rome on 4 June, he immediately left for Italy. Arriving in Rome on the fifth, he helped to identify a number of important scientific intelligence objectives, including questioning of the members of the physics laboratory at the University of Rome. A reconstituted ALSOS group for Italy carried out this and other tasks. Two Manhattan officers, Maj. R. C. Ham, who took charge of the group when Pash returned to England, and Maj. Robert R. Furman, a special projects officer from Groves's Washington staff, played an important part in its work. The results of the group's investigations tended to reaffirm those of the earlier ALSOS mission that German atomic activities were on a very limited scale.[6]

Manhattan's Special Intelligence Activities, 1944

Anticipating that ALSOS would continue its operations in Western Europe, Groves established a liaison office in London. In December 1943 he sent Major Furman to make preliminary arrangements with the British government, and in January 1944 he assigned Capt. Horace K. Calvert, chief of the Manhattan District's security program, to head the new office. Calvert quickly established working relations with G-2, European Theater of Operations, U.S. Army (ETOUSA), with the American embassy, and with the British atomic energy organization, and also assembled a small staff of researchers and investigators.

In the early months of 1944, Calvert's group concentrated on collecting further background data on German atomic activities, seeking especially to obtain more information on the number of atomic scientists and technicians at work, on the location of physics laboratories and industrial facilities engaged in operations related to atomic energy, and on the mining and stockpiling of ores containing fissionable materials (uranium and thorium). For example, by perusing German physics journals and questioning refugee European scientists, they learned the names and likely whereabouts of the most important German atomic scientists; and by periodic aerial surveillance of the mines at Joachimsthal (Jachymov), Czechoslovakia, they maintained a check on the production of uranium ore, an indicator of the extent of German atomic activities. Thus by the time a revived ALSOS mission prepared to follow the Allied invasion that summer, the London group had ready a promising list of matters to be investigated.[7]

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[5] Groves, *Now It Can Be Told*, p. 194; MPC Min, 28 Jul 44 and 24 Feb 45, MDR.

[6] Groves, *Now It Can Be Told*, pp. 208–10; Pash, *ALSOS Mission*, pp. 30–32.

At the same time, other representatives of the American program were in England to advise the Allied military leaders on development of defense measures against atomic weapons. There had been a growing conviction among a number of the administrative and scientific leaders of the Manhattan Project that the Germans might employ some type of atomic weapon, either in attack upon Great Britain or in defense against an Allied landing in Western Europe. Most American scientists believed that if the Germans did attempt to employ nuclear materials on the battlefield, they would use radioactive fission products in the form of some kind of poison gas. The Germans, the American scientists reasoned, were most likely to have concentrated their efforts on development of a plutonium-producing pile, because this was the method that promised to produce the most active material with the least investment in plants and fissionable materials. The Americans knew from their own experience that pile operation produced not only plutonium but also a large amount of radioactive by-products. If the Germans had succeeded in developing and operating a pile—and no one was certain they had not—they would have built up a considerable supply of these radioactive materials.[8]

General Groves, very much aware of the possibility of radioactive warfare, took specific measures to inform American and British military leaders of how to deal with the threat. In late 1943, he directed that a project team prepare an instruction manual on the use of radioactive materials in warfare, for distribution to the military leaders, and in December, with the concurrence of General Marshall, he authorized a briefing of four officers from the ETOUSA staff temporarily on duty in the United States. Maj. Arthur V. Peterson, a chemical engineer long associated with the pile program, conducted the briefing at the Metallurgical Laboratory, including information on probable uses of the materials, their effects and how they could be treated, and possible defense measures. He also instructed the four officers to inform key officers in ETOUSA, suggesting they report any unusual or unexplained symptoms observed by medical personnel and fogging of films detected by signal or air personnel. Headquarters, ETOUSA, took the recommended actions promptly, but in the early months of 1944 found no evidence of the use of radioactive materials by the Germans.[9]

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[7] Groves, *Now It Can Be Told*, pp. 194–98.

[8] MPC Min, 14 Dec 43, MDR; MPC Rpt, 4 Feb 44, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab C, MDR; Groves, *Now It Can Be Told*, pp. 199–200. See also the several reports, memorandums, and other documents pertaining to how the Germans might use radioactive materials for military purposes in Admin Files, Gen Corresp, 319.1, MDR. Because of this threat, the Manhattan District during the summer of 1943 supplied its area offices in Boston, Chicago, New York, and San Francisco, as well as Groves's headquarters in Washington, D.C., with Geiger counters as a means to detect the presence of radioactivity in the event of an air raid.

As time for the Allied invasion of Western Europe approached, General Groves turned his attention to the possibility that the Germans would employ radioactive warfare to disrupt the landings on the Continent. He consulted with a number of Manhattan Project leaders but did not get any information or helpful advice, except from James B. Conant. He decided, nevertheless, to warn General Dwight D. Eisenhower, Commanding General, Supreme Headquarters, Allied Expeditionary Force (SHAEF), directly of the danger of radioactive poisoning. With approval from General Marshall, he sent Major Peterson to England to brief Eisenhower and his chief of staff, Lt. Gen. Walter Bedell Smith, and other members of the SHAEF and ETOUSA staffs. Eisenhower's reaction was restrained. "Since the Combined Chiefs of Staff have not brought this information officially to my notice," he wrote to Marshall, "I have assumed that they consider, on the present available intelligence, that the enemy will not implement this project. Owing to the importance of maintaining secrecy to avoid a possible scare, I have passed this information to a very limited number of persons; moreover, I have not taken those precautionary steps which would be necessary adequately to counter enemy action of th nature."[10]

Nevertheless, Eisenhower did ta several measures to alert his co mand. Briefings on radioactive wa fare were held for the chiefs of th American Navy, Army Air Forces, an logistical commands in Europe, well as for a limited number of the staff members. He also informed L Gen. Sir Hastings L. Ismay, Chief Staff to Prime Minister Churchill. the request of the Supreme Hea quarters, ETOUSA prepared a plan operation for the American forc under the code name PEPPERMIN which provided that detection equip ment be readied for quick dispatch t the Continent, if needed, and mad arrangements for obtaining mor equipment and the technical person nel required to use it. The plan als called for briefing of specified sta officers and again requested report of unexplained fogging of photo graphic film and certain types of clini cal symptoms and medical cases. Th British subsequently devised a simila plan. A short time before the invasion of Normandy, Headquarters, Chemical Warfare Service, ETOUSA, carried out rehearsals of Operation PEPPERMINT to test the plan and equipment. Aerial and ground surveys checked for presence of radioactivity in bombed areas along the coast of England and at troop- and supply-concentration centers. Survey results indicated that the Germans had not used radioactive materials, so Operation Peppermint never went into effect.[11]

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[9] Memo, Maj Peterson to Groves, sub: Special Instruments, 14 Jun 43; Memo, Nichols to Groves, 30 Oct 43; Manual on Use of Radioactive Materials in Warfare, no author. All in Admin Files, Gen Corresp, 319.1, MDR. Memo, Groves to Chief of Staff, 23 Jul 43, Admin Files, Gen Corresp, 020 (Chief of Staff), MDR. MDH, Bk. 1, Vol. 14, Foreign Intel Supp. 2 (by Lt Col Arthur V. Peterson), pp. 4–6, DASA. Groves, *Now It Can Be Told*, p. 200.

[10] Quotation from Ltr, Eisenhower to Marshall, 11 May 44. See also Memo, Groves to Chief of Staff, 22 Mar 44. Both in OCG Files, Gen Corresp, Groves Files, Fldr 18, Tab A, MDR.

ALSOS Operations in Western Europe, 1944–1945

In early 1944, while planning its special intelligence objectives, the Manhattan Project also took the initiative to reestablish an even larger Alsos mission in Western Europe. Groves and Bush in March requested the newly assigned Army G–2, Maj. Gen. Clayton L. Bissell, to form a new Alsos group along the same lines as the earlier Italian mission. Bissell agreed a new high-level scientific organization was needed to exploit intelligence opportunities in the wake of the invasion armies, but there was indecision in the War Department General Staff as to what kind of organization should be used. Concerned by the delay, Groves personally intervened with the G–2. As a result, the Deputy Chief of Staff, Lt. Gen. Joseph T. McNarney, approved a reorganization plan on 4 April, with Groves and Bush selecting the military and civilian scientific personnel and General Bissell the intelligence and administrative staff.[12]

The new Alsos mission had its own advisory committee, a scientific director, and an enlarged staff of military and civilian personnel. The advisory committee was comprised of the directors of Naval Intelligence and the OSRD, the commanding general of the Army Service Forces, and the Army G–2, each of whom appointed a deputy to carry out the actual work of supervising the mission. The committee members and their deputies shared responsibility with the scientific director, Samuel A. Goudsmit, a physicist from the University of Michigan, who had been on leave to work at MIT's Radiation Laboratory.

Born in the Netherlands and educated in European universities, Goudsmit had a first-rate scientific reputation and a command of several languages. As a student and later a frequent visitor to many of the scientific centers of Europe, he had become personally acquainted with many of the leading physicists on the Continent. That he had not been employed on the Manhattan Project was an advantage, because, in the event of his capture by the enemy, he could not be forced to reveal secret information about the atomic program.[13]

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[11] Ltr, Eisenhower to Marshall, 11 May 44; Admin Memo 58, Office of Chief Surg, ETOUSA, sub: Rpt of Epidemic Disease, 3 May 44. Both in OCG Files, Gen Corresp, Groves Files, Fldr 18, Tab A, MDR. Admin Memo 60, Office of Chief Surg, ETOUSA, sub: Rpt on Fogging or Blackening of Photographs or X-ray Film, 3 May 44, reprinted in Groves, *Now It Can Be Told*, pp. 203–04. MDH, Bk. 1, Vol. 14, Supp. 2, pp. 6–10, DASA.

[12] Groves, *Now It Can Be Told*, p. 207; Ms, Bidwell, "Hist Mil Intel Div," Pt. 5, pp. 6.26–6.27, NARS; Groves Diary, 2, 6, 10 Mar and 3 Apr 44, LRG.

[13] Except as otherwise indicated, account of second phase of the Alsos mission based on MDH, Bk. 1, Vol. 14, Supp. 1, pp. 2.2–2.4 and 4.1–4.50, DASA; Ms, Bidwell, "Hist Mil Intel Div," Pt. 5, pp. 6.26–6.41, NARS; Groves, *Now It Can Be Told*, pp. 207–49; Thiesmeyer and Burchard, *Combat Scientists*, pp. 165–79; Pash, *ALSOS Mission*, pp. 52–248; Samuel A. Goudsmit, *ALSOS* (New York: Henry Schuman, 1947), pp. 14–127. Data on the German atomic program in World War II drawn from David Irving, *The Virus House* (London: William Kimber, 1967), subsequently published in an American edition under the title *The German Atomic Bomb: The History of Nuclear Research in Nazi Germany* (New York: Simon and Schuster, 1968); Albert Speer, *Inside the Third Reich—Memoirs*, trans. from the German by Richard and Clara Winston (New York: Macmillan Co., 1969), pp. 269–72; Michel Bar-Zohar, *The Hunt of German Scientists*, trans. by Len Ortzen from the French *La Chasse aux Savants allemands* (New York: Hawthorn Books, 1967).

With assistance from the OSRD, Goudsmit expanded the civilian scientific staff until, by the end of August, it included more than thirty scientists. Colonel Pash, after establishing a London office, recruited additional military personnel required for the increased administrative and operational duties of a larger mission. For purposes of military administration and supply, Alsos was attached to the Office of the Assistant Chief of Staff, G–2, ETO. In spite of direct support from Eisenhower's headquarters, Pash experienced some difficulties in securing adequate counterintelligence personnel and in making other organizational arrangements. Part of the problem was that Alsos's high security classification limited knowledge of its purpose and activities to only a few high-ranking Allied officers.

While the directive establishing the new Alsos stated its mission in very broad terms (it was to secure "all available intelligence on enemy scientific research and development, particularly with reference to military application"), both its military and scientific leaders viewed its primary purpose to be uncovering and analyzing German atomic activities. Furthermore, the limited size of its staff (there were never more than slightly over one hundred military and civilian personnel) precluded any extensive investigations outside the nuclear physics field, although it did give some attention to bacteriological warfare, aeronautical research, proximity fuses, guided missiles, and similar developments.

The first Alsos operations in France were largely unproductive investigations at the University of Rennes and at L'Arcouest, where Joliot-Curie's summer home was located. Joliot was not in L'Arcouest, but Colonel Pash, Major Calvert, and two counterintelligence agents found him in his laboratory at the College de France when they accompanied the 2d French Armored Division as it led the forces liberating Paris in late August 1944. After receiving news of the French physicist's whereabouts, the Alsos scientific director proceeded to Paris to interview Joliot. Goudsmit subsequently learned that the German scientists had used Joliot's cyclotron and other laboratory facilities; however, he failed to obtain enough data during the interview to determine the extent of enemy progress in atomic matters.[14]

Alsos investigative efforts became much more productive following relocation of its headquarters from London to Paris in mid-September 1944. Alsos teams established contact with officials of the Belgian uranium mining firm, Union Miniere du Haut Katanga, and obtained information on the shipments of uranium products that had gone into Germany. They also learned that there were still uranium materials in Belgium and that other stock had been shipped to France. Groves undertook immediate measures to bring these materials under control of the Manhattan Project agency that had been formed for that purpose, the Combined Development Trust, and dispatched Major Furman, who had taken part in the Italian Alsos mission, to locate all uranium stocks in areas under Allied control.

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[14] Key provisions of the Alsos directive are quoted in Ms, Bidwell, "Hist Mil Intel Div," Pt. 5, p. 6.29, NARS.

Soon Alsos teams had tracked down and secured 68 tons of uranium materials in Belgium and about 30 tons at Toulouse, France. Groves directed prompt shipment of these stocks to England and thence later to the United States for safekeeping. A subsequent Alsos mission located and eventually secured substantial uranium stock in storage near Stassfurt in central Prussia.[15]

As Allied armies moved eastward toward the Rhine in the fall of 1944, Alsos teams gained considerable knowledge about the probable locations of German atomic activities. Research had begun at the Kaiser Wilhelm Institute in Berlin but had been moved near the small towns of Hechingen and Bissingen in Wuerttemberg, located in the Black Forest region of southwest Germany, when heavy bombing of the German capital started in 1943. Aerial photo surveillance instituted by the Manhattan intelligence office in England that summer had concluded new construction there was not an atomic plant, but other Allied intelligence sources indicated the Germans had some kind of atomic operations in progress in the area. Questioning of German prisoners, too, had cast suspicion on the town of Oranienburg, 18 miles north of Berlin, as a possible location of a processing plant for thorium and other ores related to atomic energy research.

Finally, in late November 1944, Alsos representatives were able to question German atomic scientists at the University of Strasbourg. The 6th Army Group's special unit, the Strasbourg T-Force, and Alsos teams entered the city with the first Allied elements. From the scientists and the documents they found there, they learned that Germany's wartime atomic research program had begun in early 1942. It had not, however, gotten beyond the research and development stage. When the Nazi leaders had learned of the possibility of producing atomic weapons, they had offered to provide the atomic program with more money. But the German scientists had turned down the funds as premature. By 1944, they still had not discovered an effective way to separate U-235 from ordinary uranium, although they had succeeded in manufacturing uranium metal for use in the piles they had built. They had not, however, attained a chain reaction in these piles.[16]

While the Strasbourg data indicated strongly that the Nazis had not achieved significant progress toward the fabrication of atomic weapons, it was not sufficient to convince General Groves, Allied military leaders, and Allied scientists. Some argued, for example, that the Strasbourg evidence might have been planted deliberately. In fact, some Alsos military members advocated bombing raids on suspected German atomic sites in the Black Forest region, but Alsos scientists dissuaded them from this course.

The latter group, however, raised no objections to Groves's request for bombing of installations at Oranienburg. The town was in the projected Russian occupation zone and therefore could not be investigated by Alsos. Groves dispatched an officer from his staff to explain the mission to General Carl A. Spaatz, commander of the United States Army Strategic Air Forces in Europe, who on 15 March 1945 ordered Eighth Air Force bombers to drop almost 1,300 tons of bombs and incendiaries on the facilities at Oranienburg.[17]

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[15] On the Combined Development Trust see Ch. XIII. For further details on the seizure and handling of captured stock see Ms, "Diplomatic Hist of Manhattan Proj," pp. 31-32, HB Files, Fldr 111, MDR, and MDH, Bk. 1, Vol. 14, Supp. 1, pp. 4.36-4.37, DASA.

[16] For a description of the efforts of the Nazi government to provide support for the German atomic program see Speer, *Inside the Third Reich*, pp. 269-71, and Stimson Diary, 13 Dec 44, HLS.

Preparing to follow the Allied armies into Germany in early 1945, Alsos corrected certain organizational weaknesses revealed during the Strasbourg operations. Full-time assignment of German-speaking scientists helped ensure their prompt availability when they were most needed. Establishment of close liaison with SHAEF and ETOUSA headquarters, in Paris, and with the 21st, 12th, and 6th Army Groups headquarters enabled Colonel Pash to keep more abreast of front-line military developments, and hence in a better position to exploit intelligence opportunities.

The reorganized Alsos units demonstrated their greater effectiveness as they followed the Allied armies toward the Rhine in February 1945. Establishing another advance base at Aachen, they investigated scientific intelligence objectives in the university cities of Cologne and Bonn, at metal-making plants in Frankfurt, and, a short time later, at the IG Farben Industries plants in Ludwigshafen. As Alsos scientists had anticipated, none of these investigations turned up significant information on German atomic developments. But they helped to prepare the way for effective exploitation of the important atomic objectives in southwest Germany.

The first of these to become accessible in the spring of 1945 was Heidelberg. There an Alsos team captured several leading German atomic scientists; nuclear equipment, including a cyclotron; and many valuable documents. Data uncovered in Heidelberg also further substantiated earlier evidence that most of the other important German atomic scientists and their research installations were in the region south and east of Stuttgart. But Alsos penetration of this area posed a problem because of the decision by the Allied leaders in early 1945 that it fell within the French zone of operations.

In April 1945, while American atomic leaders endeavored to work out a solution to the French zone problem, Alsos teams operating out of advanced base headquarters at Heidelberg and Aachen investigated a variety of atomic targets at other points in west and southwest Germany. Northeast of Frankfurt, at the town of Stadtilm in Thuringia, where the German government had relocated a part of the physics branch of the Kaiser Wilhelm Institute, Alsos found many technical documents relating to the atomic program, parts for a low-temperature pile, heavy water equipment, and 8 tons of uranium oxide. The Gestapo had evacuated the most important laboratory staff members, but Alsos scientists interviewed a number of lesser status who had remained in Stadtilm. At the university town of Goettingen, located south of the city of Hannover, and at the adjoining village of Lindau, another Alsos team found several scientists and technicians who had considerable knowledge of German wartime scientific programs. Most notable among this group was the chief of the planning board of the *Reichsforschungsrat* (National Research Council), the central German agency for scientific research for military purposes. From Goettingen, an Alsos team pushed north to Celle, located 22 miles northeast of Hannover, where, according to information obtained at Stadtilm, the Germans had installed an experimental centrifuge for separating uranium isotopes. On the seventeenth, the team found the centrifuge in a laboratory located in a spinning mill guarded by British troops.

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[17] Wesley Frank Craven and James Lea Cate, eds., *Europe: Argument to V–E Day, January 1944 to May 1945*, The Army Air Forces in World War II, Vol. 3 (Chicago: University of Chicago Press, 1951), pp. 53 and 753. The account of the bombing of Oranienburg on 15 Mar 45 indicates that the town was a railroad center and site of aircraft plants, but does not mention atomic facilities. See also Groves, *Now It Can Be Told*, pp. 230–31.

These various findings by Alsos teams appeared further to confirm that the German wartime atomic energy program was of relatively modest character and had made little progress toward producing atomic weapons. But the American atomic leaders could not be fully satisfied that this was the case until Alsos teams had investigated the reported atomic facilities relocated by the Germans from the Berlin area to the Black Forest region in Wuerttemberg and had captured the principal German atomic scientists believed to be residing in that area. They also agreed that, for reasons of security, American troops must be the first to occupy and inspect these facilities. Their first hope was that zone boundaries in southwest Germany could be adjusted to exclude the atomic facilities from the French zone. But by early April, the State Department's insistence upon having full knowledge of the reasons for making readjustments—a request incompatible with Manhattan's security requirements—convinced Groves that other means must be found to assure American penetration ahead of the French in the crucial Wuerttemberg region. On the fifth, Groves, Marshall, and Stimson agreed that the Manhattan commander should implement his own proposal that Alsos teams, accompanied by American troops, move into the Wuerttemberg region, question German atomic scientists found there, remove appropriate records, and destroy the atomic installations.[18]

Marshall directed Groves to coordinate with the Operations Division of the War Department and SHAEF in developing a plan for what came to be known as Operation Harborage.[19] Groves sent his special assistant for security affairs, Lt. Col. John Lansdale, Jr., to Europe to assist the SHAEF planners. They first considered carrying out a combined parachute and ground operation, but by 20 April the rapidly shifting tactical situation had eliminated the need for the air phase of the operation. Instead, SHAEF ordered Colonel Pash to undertake a conventional intelligence operation, with the objective of seizing appropriate persons, documents, buildings, and materials. For this purpose, the Supreme Headquarters created a new special task force, designated T-Force. Comprised of fourteen American and seven British officers, five scientists, eight counterintelligence agents, and fifteen enlisted men, T-Force was attached to the 6th Army Group and reinforced by the 1269th Engineer Combat Battalion (less Company B), all under the command of Pash. When French forces appeared to be on the verge of moving in to the Wuerttemberg area in late April, SHAEF gave Pash permission to launch Operation HARBORAGE. On the twenty-second, Pash, accompanied by Brig. Gen. Eugene L. Harrison, G–2 of the 6th Army Group, led T-Force across a bridgehead at Horb, on the Neckar River, about 56 miles east of Strasbourg. They moved south and east 20 miles to Haigerloch, which they seized on the twenty-third. In the next two days, T-Force elements also occupied Hechingen, 9 miles east of Haigerloch, and Bissingen, a few miles southwest, and Tailfingen, a few miles southeast of Hechingen, thus completing a sweep of the Black Forest villages suspected of having atomic installations or personnel.

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[18] Stimson Diary, 4–5 Apr 45, HLS.

[19] General Groves gives a detailed account of his role in the planning of Operation Harborage in *Now It Can Be Told*, pp. 233–36.

What the ALSOS scientists found in these communities finally and definitely confirmed the limitations of the wartime German atomic program. "It was so obvious," Samuel Goudsmit later recalled,

> that the whole German uranium set up was on a ludicrously small scale. Here [at Hechingen] was the central group of laboratories, and all it amounted to was a little underground cave, a wing of a small textile factory, a few rooms in an old brewery. To be sure, the laboratories were well-equipped, but compared to what we were doing in the United States it was still small-time stuff. Sometimes we wondered if our government had not spent more money on our intelligence mission than the Germans had spent on their whole project.[20]

Besides laboratories and equipment, ALSOS teams found concealed supplies of heavy water, 1.5 tons of metallic uranium cubes, 10 tons of carbon, and miscellaneous other nuclear materials. They also located important scientific and technical records, but most significant were the German scientists they took into custody. These included Otto Hahn, who, with Fritz Strassmann, had conducted in 1938 the experiments that resulted in the fissioning of uranium by neutrons, subsequently confirmed by Lise Meitner and Otto R. Frisch.

Not all of the known remaining leaders of German atomic science were found in the Black Forest region, but information uncovered there led to capture in May 1945 of those still at large by other ALSOS teams operating in Bavaria. These included the world-famous Werner Heisenberg, a Nobel Prize winner, and Walther Gerlach and Kurt Diebner, two of the chief administrative officials in the German atomic program. After preliminary interviews by ALSOS field teams, Allied authorities removed the captured scientists by easy stages to rear areas—first to Versailles, then Belgium, and finally in July to England—where they were subjected to further intensive interrogation. Although the enemy scientists were under British administrative control during their extended internment in England, representatives of the Manhattan Project exercised a consultative role in determining their intelligence exploitation and ultimate disposal. Unwilling to see the German scientists come under Russian control, both British and American atomic authorities insisted on detaining them in England until there was a reasonable assurance that when they returned to Germany they would reside and work in either the British or American occupation zone, a condition that was not finally met until the end of 1945.[21]

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[20] Goudsmit, *ALSOS*, pp. 107–08.

Alsos continued operating in the wake of the Allied armies in the summer and fall of 1945, seeking additional evidence of German atomic developments. Penetrations to Hamburg, Berlin, Vienna, and elsewhere resulted in the capture of a few more scientists but provided little additional new information or facilities. When the Alsos mission finally disbanded in November, it had, as General Groves later assessed its results, "only confirmed what we already knew and it was quite clear that there was nothing in Europe of further interest to us."[22]

When the interned German scientists learned that the United States had dropped atomic bombs on Japan in August 1945, they endeavored to explain why Germany failed to develop an atomic weapon. Their explantion coincided generally with the picture that Alsos teams had pieced together from the evidence they had gathered in Germany. Although German scientists had begun research on the practical application of atomic energy in 1939, they soon had come to the conclusion that, because of limited resources and facilities available to them, production of atomic explosives was not feasible and had concentrated on developing an atomic engine as an alternate source of power. They had persisted along these limited lines even after Albert Speer, the Nazi Minister of Armaments, had offered in 1942 to increase financial support for the atomic program. Speer later recalled that Heisenberg and other German atomic scientists had given him the distinct "impression that the atom bomb could no longer have any bearing on the course of the war."[23] Administrative problems, too, had plagued the program; a partial consolidation in 1942 had not ended the fragmentation and duplication that had developed when atomic research had been divided among three different and competing governmental agencies. In the estimate of the historian of the German program, the combined effect of these negative factors was that "after the middle of 1942, Germany virtually marked time until the end of the war, gaining in those three years knowledge that could have been won in as many months had the will been there. . . . Germany's nuclear scientists failed to win the confidence of their government, and were left stranded on the shores of the atomic age."[24]

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[21] On the internment and treatment of the German scientists in England see Groves, *Now It Can Be Told*, pp. 333–40.

[22] Ibid., p. 248.

[23] Speer, *Inside the Third Reich*, p. 271.

[24] Irving, *The Virus House*, p. 274. See also Alan D. Beyerchen, *Scientists Under Hitler: Politics and the Physics Community in the Third Reich* (New Haven: Yale University Press, 1977), pp. 188–89, 193–97, 201–02.

CHAPTER XIII

The Raw Materials Program

From the very beginning of the atomic energy project, one of the most important activities was procurement of basic raw materials, many of them never before in great demand. The Office of Scientific Research and Development had begun acquiring a number of these materials through the planning board of its S–1 Section and through Stone and Webster, and in mid-1942, when the project was placed under the direction of the Army, the Manhattan District assumed responsibility for the ongoing materials program. With the long-range objective of ensuring America's control of the world's more significant deposits of uranium and thorium,[1] the District almost immediately became involved in acquisition efforts at an international level. This, project leaders felt, was critical to national security and would prevent unfriendly nations from securing these supplies.

Geographic Search and Field Exploration

In October 1942, shortly after General Groves became executive officer of the Manhattan Project, Deputy District Engineer Nichols and Union Miniere Director Edgar Sengier successfully completed negotiations for the District's acquisition of the company's remaining stocks of mined uranium ore, stored on Staten Island and in the Congo,[2] thus assuring the atomic program a sufficient supply to meet its wartime requirements. Yet in the ensuing months, project leaders gradually came to realize that raw materials procurement could not be limited to meeting only the immediate wartime demands. First, by their decision to build and operate several large production plants, they had established a requirement for a continuing supply of uranium, not only for the wartime weapons program but also for postwar armaments and development of atomic energy as a great new source of power. Second, they became increasingly aware of important strategic considerations as, beginning in 1943, the United States negotiated interchange agreements with

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[1] When thorium 232 captures a slow neutron, it converts into thorium 233. The thorium then disintegrates quickly into protoactinium 233, which then decomposes, but more slowly, into uranium 233. Uranium 233 is fissionable by slow neutrons and thus potentially a material for sustaining a chain reaction. Thorium, like uranium, occurs widely in the earth's crust, but similarly not often in sufficient concentration to provide economically workable deposits. Before World War II, it was most commonly used in the manufacture of gas mantles.

[2] See Ch. IV for details on acquisition of Belgian ore.

Great Britain. Both the American and British leaders concluded that the best future interest of the two countries would be served by a joint effort to seek out and gain control over as much of the world's uranium and thorium deposits as possible; this policy, they reasoned, would ensure their governments ready access to major new resources of inestimable value and would keep these resources out of the hands of their potential enemies. Furthermore, project leaders perceived that, strictly from the viewpoint of national interest, it would be better for the United States to conserve its own apparently limited domestic resources and use whatever raw materials it could acquire from other countries instead.[3]

Although occupied with a myriad of other matters relating to plant construction in early 1943, General Groves took time to develop an organization for carrying out the project's long-range raw materials objectives. He presented his ideas to the Military Policy Committee at its 5 February meeting, emphasizing that he wanted to have "a competent mining expert examine the possibility of developing in the United States a suitable source of supply of the crucial ores." By late March, the Manhattan commander was discussing the possibility of engaging the Union Carbide and Carbon Corporation, already under contract to operate the gaseous diffusion plant at Clinton, to undertake a broad program of ore exploration for the Manhattan Project.[4]

Groves's selection of Union Carbide rather than some other company, or the Manhattan District, or another government agency was due to a number of considerations, with the security aspect of primary importance. Because Union Carbide made regular foreign purchases of many uranium minerals, he felt it was highly unlikely that the chemical firm's ore exploration activities for the District would attract any undue attention. Also especially attractive was the fact that the company, because of its long experience in mineral surveys and explorations, currently had an organized—although inactive—subsidiary, the Union Mines Development Corporation, to administer the ore program. Following negotiations, Union Carbide agreed to activate Union Mines, and on 24 May, Union Mines President J. R. Van Fleet accepted a letter contract. Under terms of this contract, Union Mines would carry out a worldwide search for new sources of uranium, evaluate its findings, and make recommendations as to the best way for the United States to explore them; the government would pay all costs; and Union Mines would work without a fixed fee or profit.

For reasons of security, and to avoid duplication of administrative overhead operation, Union Mines located its headquarters in the New York City office building already occupied by other elements of Union Carbide. Security also was the main consideration in the administrative decision to set up a separate Manhattan unit for monitoring Union Mines survey and exploration activities, as well as to maintain liaison with District headquarters and its major procurement office at Madison Square. On 15 June, in rooms adjacent to those of Union Mines, the district engineer established the Murray Hill Area Engineers Office and, as area engineer, assigned Maj. Paul L. Guarin.[5]

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[3] MPC Rpt, 21 Aug 43, Fldr 25, Tab E; MPC Min, 24 Jun 43, Fldr 23, Tab A. Both in OCG Files, Gen Corresp, MP Files, MDR. Groves, *Now It Can Be Told*, p. 180. Ms (unsigned), "Atomic Bombs," Apr 45, HB Files, Fldr 15, MDR.

[4] MPC Min, 5 Feb (source of quotation) and 30 Mar 43, MDR.

While Major Guarin was organizing a small staff of technical experts and clerks, Union Mines started recruiting trained personnel for its staff. By mid-1944, the company had assembled approximately 130 individuals, assigning half of them to the New York office and the rest to field projects in the United States and abroad. To achieve its program objectives, Union Mines organized staff functions along several lines. The New York-based geologists, translators, and clerks concentrated on a thorough search of available technical literature on world mineral resources, in all languages. Field teams of mining engineers and geologists investigated known or suspected sources of uranium and thorium. A small group in New York studied ways to improve the methods and equipment for ore exploration, and another small unit at Union Mines headquarters oversaw research on beneficiation and metallurgical processes that might be suitable for concentration of uranium ores. Making maximum use of the nearby facilities of Union Carbide, Union Mines was able to administer the entire ore program with a relatively small overhead staff and at a cost of approximately $600,000 a year.[6]

During the period of its wartime operations, Union Mines supplied Manhattan leaders with a variety of reports. After studying the various instruments and techniques for area surveying and ore testing, Union Mines research staff compiled data on the latest or improved devices for detecting uranium and thorium deposits and for testing ore samples. It also examined some sixty-five thousand volumes and, based on its findings, produced fifty-six reports covering occurrences of uranium and thorium in about fifty different countries, including not only enemy-controlled lands such as Czechoslovakia and Thailand but also areas as remote as Greenland and Madagascar. And from the company's field exploration program, field teams prepared a total of fifty-seven reports of investigations carried out in thirty-six states and the territory of Alaska and about forty-five reports of investigations conducted in some twenty foreign countries.[7]

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[5] Groves, *Now It Can Be Told*, p. 180; First Annual Rpt, Murray Hill Area Engrs Office, sub: Proj S-37, 30 Jun 44, pp. 1-2, OROO; Memo, Guarin to Groves, sub: Union Mines Proj, 6 Jul 44, Admin Files, Gen Corresp, 095 (Union Mines), MDR; MDH, Bk. 7, Vol. 2, "Geographical Exploration," pp. 1.1-1.3, DASA.

[6] Rpt, Murray Hill Area Engrs Office, 30 Jun 44, pp. 2-8, 12-13, 42-44 (Charts 2-4), OROO; Groves, sub: Union Mines Proj, 6 Jul 44, MDR; MDH, Bk. 7, Vol. 2, pp. 1.2-1.3 and 3.2-3.5, DASA.

[7] MDH, Bk. 7, Vol. 2, pp. 1.4-1.16 and Apps. B1 (list and summary of all reports by Literature Research Div-B5), DASA. Rpt, Murray Hill Area Engrs Office, 30 Jun 44, pp. 22-34, OROO. Memo, Merritt to Nichols, sub: Resume of Prod of Uranium Products for MD in Colorado Plateau Area, 26 Jan 45, 410.2 (Uranium); Rpt, Union Mines, sub: Summary of Investigations to 1 Feb 44, same date, 095 (Union Mines). Both in Admin Files, Gen Corresp, MDR. Ltr, Stimson to MacArthur (Cdr in Chief, SW

Continued

Beginning in early 1944, the Murray Hill area engineer used the Union Mines data to provide the district engineer with comprehensive lists appraising uranium production possibilities in various countries. A typical list, for example, rated occurrences in the Belgian Congo as excellent; those in the United States, Canada, and Sweden as good; those in Czechoslovakia, Portugal, and Union of South Africa as fair; and those in Madagascar, Australia, Brazil, and England as poor. By 1945, the area engineer was also including reports on thorium. Brazil and India were rated excellent, while the United States, Korea, Netherlands East Indies, Malaya, and Siam were judged fair. In this manner, the Union Mines data provided the essential guidelines for reaching the long-range objective of the ore program.[8]

Ore Control Agency: Combined Development Trust

By the summer of 1943, the American atomic project's supply requirements for sufficient raw materials had convinced its leaders of the importance of establishing adequate control over the world's more significant deposits of uranium and thorium. In its 21 August report to the President, the Military Policy Committee advanced this idea, warning that "the major world supply [is] in the Belgian Congo [and] not under our control in any way.[9] This situation, the committee felt, did not bode well for the United States, especially in the postwar era: America's knowledge and technical capability to fabricate atomic weapons would be of no avail without the raw materials to do the job.

How to secure these raw materials became a priority issue for project leaders, who felt one way was to gain control over the Congo supply. During the fall, Colonel Nichols attempted to convince Union Miniere Director Edgar Sengier that the flooded Shinkolobwe mine should be reopened and its entire future output sold to the United States; however, Sengier, who understood the potential of atomic power, did not wish to make any commitments that he could not later justify to the Belgian government as having been based upon military requirements.

The American failure to secure a long-term contract from Sengier for future production of Congo ore came up for discussion at the 14 December meeting of the Military Policy Committee. The consensus of the committee was that, with the Belgian government in exile in London and British commercial interests apparently holding or having direction over nearly a third of Union Miniere stock, Great Britain was likely to gain control of the Congo uranium. So from the American point of view, the committee concluded, the best move would be to secure joint control. Conse-

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Pacific Area), 31 Mar 44, HB Files, Fldr 25, MDR. Stimson wrote to MacArthur requesting clearance for a visit by a Union Mines representative interested in "information [on] certain natural resources which might be found in your theater."

[8] Rpt, Murray Hill Area Engrs Office, 30 Jun 44, pp. 8–11, OROO. MDH, Bk. 7, Vol. 2, pp. 1.16–1.21, DASA. Rpt, Union Mines, sub: Summary of Investigations to 1 Feb 44, same date; Memo, Guarin to Groves, sub: Union Mines Proj, 6 Jul 44. Both in Admin Files, Gen Corresp, 095 (Union Mines), MDR.

[9] MPC Rpt, 21 Aug 43, MDR. Although signed by Bush, Groves had drafted this report.

quently, on the seventeenth, the American and British members of the Combined Policy Committee,[10] agreed to begin studies preparatory to recommending joint action.[11]

Speaking for the Military Policy Committee, General Groves recommended to the President in February 1944 that the Belgians be "strongly encouraged" to reopen the Shinkolobwe mine and that the United States and Great Britain take whatever steps were necessary to ensure "joint control" of uranium in the Congo. The two countries also should collaborate to secure all accessible supplies elsewhere, "not only for the period of the war, but for all time to come." The Top Policy Group endorsed these recommendations and, on the fifteenth, Secretary Stimson and OSRD Director Vannevar Bush lunched with Roosevelt and secured his approval.[12]

Following these recommendations, the Combined Policy Committee gave its tentative approval to a draft plan for American-British-Canadian collaboration on 17 February. The committee would establish a Washington-based business corporation, or similar agency, headed by a board of six directors (three to be chosen by the United States, two by Great Britain, and one by Canada), and the United States would pay half the cost of the organization, Great Britain and Canada the rest. As directed by the committee, the new organization would give first consideration to obtaining control of the Congo ore deposits.[13]

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[10] Churchill and Roosevelt's signing of the Quebec Agreement on 19 Aug 43 established the Combined Policy Committee in Washington, D.C., with membership as follows: Secretary Henry L. Stimson (United States), as chairman, Dr. Vannevar Bush (United States), Dr. James B. Conant (United States), Field Marshal Sir John Dill (United Kingdom), Col. John J. Llewellin (United Kingdom), and Mr. Clarence D. Howe (Canada). Field Marshal Dill was head of the British Joint Staff Mission in Washington, Colonel Llewellin was the Washington representative of the British Ministry of Supply, and Mr. Howe was Canada's Minister of Munitions and Supply. See Gowing, *Britain and Atomic Energy*, pp. 170–72, and Groves, *Now It Can Be Told* pp. 133–37.

[11] MPC Min, 14 Dec 43, MDR; CPC Min, 17 Dec 43, HB Files, Fldr 10, MDR; Ms, "Diplomatic Hist of Manhattan Proj," p. 18, HB Files, Fldr 111, MDR; Groves, *Now It Can Be Told*, p. 170. After the breakdown of Anglo-American collaboration on atomic matters in early 1943, Great Britain developed a strong interest in securing a reliable source of uranium for its future needs. Two actions by the United States, however, caused leaders of the British atomic project to feel genuinely alarmed: in the spring, when the United States contracted to purchase practically the entire output of the Canadian Eldorado mine (hitherto the chief source of uranium for the British program) through the end of 1945; and in the fall, when the United States attempted to buy the entire output of the Belgian-owned Shinkolobwe mine in the Congo. The first incident was sufficient impetus for the British to seek a resumption of Anglo-American cooperation, and in August the two allies signed the Quebec Agreement. The signing of this agreement opened the way for the two atomic partners to pursue a joint program to obtain control of the world's uranium resources. Although the fall incident seemed threatening to British interests, the United States realized by the end of the year that Great Britain occupied a better vantage point and thus took the initiative to implement joint cooperation and control measures. For an account of Anglo-American problems and coordination on uranium supplies see Gowing, *Britain and Atomic Energy*, pp. 179–85.

[12] Quotations from MPC Rpt, 4 Feb 44, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab C, MDR. See also Memo, Bush to Bundy, 14 Feb 44, OCG Files, Gen Corresp, MP Files, Fldr 25, MDR; Stimson Diary, 15 Feb 44, HLS; Gowing, *Britain and Atomic Energy*, pp. 298–99.

[13] CPC Min, 17 Feb 44, OCG Files, Gen Corresp, MP Files, Fldr 9, Tab B, MDR; Stimson Diary, 17 Feb 44, HLS; Articles of Agreement Governing Collaboration Between the Authorities of the United States of America, the Kingdom of Great Britain, and the Dominion of Canada in the Matter of Uranium Ore, draft of 14 Feb 44, HB Files, Fldr 23, MDR. The draft adopted on the seventeenth does not appear to have differed substantially from that

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Final negotiations on this wartime agreement took place in London between Sir John Anderson, now Chancellor of the Exchequer, and American Ambassador John G. Winant. This arrangement made for a somewhat ticklish stituation, for neither Secretary of State Cordell Hull nor anyone else in the Department of State knew anything about the existence of the Manhattan Project. In the interest of continued secrecy, President Roosevelt took the view that Ambassador Winant was his representative, not Secretary Hull's, and that negotiations could be conducted through Winant without recourse to the Department of State. He designated Secretary Stimson to oversee the negotiations, and instructions reached Winant over Stimson's rather than Hull's signature. For these delicate negotiations then, the War Department assumed a role normally accorded to the State Department. Although highly irregular, the War Department continued to play this role in subsequent quests for overseas uranium and thorium resources.

Winant's instructions were carried by Maj. Harry S. Traynor, a highly trusted officer on the Manhattan District staff, whom General Groves detailed to brief and assist the ambassador[14] Traynor arrived in London in mid-March, armed with a letter from the President, a copy of the draft agreement, and instructions to do everything in his power to assist Winant in completing the accord as quickly as possible. "Any delay in negotiations," wrote Roosevelt to his ambassador, "might prejudice a successful conclusion."[15]

Despite this admonition for speed, nearly three months passed before the London conferees were able to resolve the intricate problems associated with preparing the so-called Agreement and Declaration of Trust. Some of these problems were legal in nature, and to aid in their solution Winant requested the assistance of Brig. Gen. Edward C. Betts, judge advocate general of General Eisenhower's European Theater of Operations headquarters, and Secretary Stimson complied. Betts, whom Winant trusted implicitly, also enjoyed the confidence of Sir Thomas Barnes, Sir John Anderson's legal adviser, and the two men worked well and easily with each other.

One legal question that arose even before Traynor left for England was raised by the President himself: If the proposed organization was established as a corporation, could its existence and transactions be kept a secret under United States law? There was general agreement that Roosevelt's concern for security was justified, and after considerable legal study, Sir Thomas suggested and General Betts agreed that the best solution was to make the organization a common law trust.

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dated on the fourteenth (cf. Hewlett and Anderson, *New World*, p. 286). The arrangement was strictly for wartime purposes. Following the end of hostilities, it was subject to review and such revisions as might be necessary to meet postwar conditions.

[14] Description of London negotiations based on voluminous collection of memorandums, reports, cables, drafts, and similar materials in HB Files, Fldrs 48, 54, 56, 60, 65, and 99, MDR. See especially narrative reports by Major Traynor in Fldr 89 and an account by him reproduced in Groves, *Now It Can Be Told*, pp. 171–74. See also Stimson Diary, Mar–Jun 44, passim, HLS.

[15] Ltr, Roosevelt to Winant, 3 Mar 44, HB Files, Fldr 60, MDR.

A second legal problem was whether the President had the authority to enter into the type of agreement contemplated. Two briefs were prepared on this question—the first, at the direction of Secretary Stimson, by Brig. Gen. Boykin C. Wright, the Army Service Forces' International Division director, who as a civilian had headed a New York law firm; and the second, on General Groves's orders, by three lawyers on the Manhattan staff: Lt. Col. John Lansdale, Jr., Maj. William A. Consodine, and Pvt. Joseph Volpe, Jr. Both briefs agreed that the proposed arrangement was within the power of the President to make executive agreements without recourse to Congress, but both also questioned the legality and practicability of establishing a corporation. General Betts seconded these conclusions, which further supported the recommendation that the organization be established as a trust.

There were also other questions. Should Canada be a signatory to the trust agreement? Should thorium be included with uranium as a valuable source of fissionable material? The question concerning Canada arose because it was not a party to the Quebec Agreement. The conferees decided to drop all references to the country from the trust agreement, but Winant and Anderson stipulated in an exchange of letters that one of the six directors of the trust would be a Canadian.[16] As for thorium, because Metallurgical Laboratory scientists in the spring of 1944 had concluded that it might eventually prove to be the best fuel for atomic piles, the conferees in London decided to include it with uranium in the Declaration of Trust.

The negotiations were monitored carefully from Washington, where Secretary Stimson, Harvey Bundy, as Stimson's special assistant for scientific affairs, and General Groves kept in close communication with Winant. Drafts of the proposed trust agreement were sent back and forth between the two capitals, and in the midst of the London talks Traynor traveled to Washington to confer with his superiors. This coordination, however, did not result in a timely resolution of the discussions, which were complicated by the fact that Ambassador Winant, Major Traynor, Sir John Anderson, and W. L. Gorell Barnes, a representative of the British Foreign Office, simultaneously were involved in quite lengthy negotiations with Belgian officials in London regarding an agreement on future control and development of the rich Congo ore—the primary reason for establishing the trust.[17]

It was early June before the conferees had coordinated and affirmed in final form all aspects of the Declaration of Trust. Prime Minister Churchill signed first, affixing his signature on two copies of the agreement. Forthwith, a special courier carried the documents to Washington, where, on the thirteenth, President Roosevelt also signed them. This trust agreement established the Combined Development Trust which, under the general direction of the Combined Policy Committee, would supervise the acquisition of raw materials in "certain areas" outside of American and British territory.[18] The individuals named as trustees, whom the committee approved at its next meeting in September, were: for the United States, Charles K. Leith, a distinguished mining engineer, George L. Harrison, a businessman and special assistant to Stimson who had been helping out on Manhattan problems, and General Groves; for Great Britain, Sir Charles J. Hambro, head of the British Raw Materials Mission, and Frank G. Lee, a British Treasury representative; and for Canada, George C. Bateman, a deputy minister and member of the Combined Resources Board in that country. At the first meeting of the Trust on the fourteenth, Groves was elected chairman and Sir Charles deputy chairman of the group.[19]

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[16] Earlier the British and Americans had agreed that Canada should share in controlling the Congo uranium supply. See Ltr, Field Marshal Dill to Bundy, 6 Mar 44, HB Files, Fldr 48, MDR.

[17] Copies of various drafts of trust agreement and related work papers in HB Files, Fldr 48, MDR. Drafts and final text of Belgian Agreement in HB Files, Fldr 57, MDR. See also Major Traynor's Notes on [First] Trip to London, England, 12 Apr 44, and Rpt on Second Trip to London, 22 May 44, submitted to Bundy, Attn: Secy War. Both in HB Files, Fldr 99, MDR.

Ore Acquisition in Foreign Areas

For the leaders of the American atomic energy project, the much enlarged program of exploration, control, and acquisition of radioactive ores in foreign areas represented the logical continuation and expansion of the ongoing ore program in the United States and Canada.[20] Because the deposits would be in countries not under American or British control, they left the problem of acquisition to the Combined Policy Committee and the Combined Development Trust. Operating at the international level, these joint American-British groups were technically outside the direct control of the Manhattan District; however, their activities inevitably were influenced greatly and related closely to those of the American project, not only because in the foreseeable future the latter would have the greatest need for fissionable materials but also because two of its influential personalities held key posts in both organizations. General

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[18] One of two originals of Agreement and Declaration of Trust, dated 13 Jun 44, the day Roosevelt signed, filed in HB Files, Fldr 49, MDR. The term *certain areas* was introduced so as not to offend Russian sensibilities when the terms of the agreement became public. Msg, Stimson to Winant, 17 Apr 44, HB Files, Fldr 106, MDR.

[19] CPC Min (draft version of minutes prepared by Bundy and Webster, the CPC's joint secretaries), 19 Sep 44, HB Files, Fldr 13, MDR; CDT Prov Min, 14 Sep 44, OCG Files, Gen Corresp, MP Files, Fldr 9, Tab B, MDR.

[20] In July 1943, Union Mines surveyed the Great Bear Lake region in Canada through a Canadian subcontractor, Ventures, Ltd. This firm was authorized to make purchases for Union Mines, but the project was barely under way when in September the Canadian government decided to take control of all radioactive substances in the Yukon and Northwest Territories, promising to keep the United States fully informed concerning all ore discoveries and to exploit them for the mutual benefit of both countries. In the spirit of the Quebec Agreement, General Groves subsequently arranged to have Union Mines terminate its contract with Ventures and transfer all of its claims to the Canadian government. Union Mines settled its contract with Ventures in late 1944, agreeing to a lump-sum payment to cover all costs incurred by the Canadian firm. See MDH, Bk. 7, Vol. 2, pp. 2.2–2.4, DASA. Memo, Groves to Bush, Purnell, and Styer, 27 Sep 44; Memo, Nichols to Groves, 17 Oct 44, Incl to Memo, Nichols to Groves, sub: Agreement With Canadian Govt, 8 Nov 44. All in OCG Files, Gen Corresp, MP Files, Fldr 2, MDR. Stanley W. Dziuban, *Military Relations Between the United States and Canada, 1939–1945*, U.S. Army in World War II (Washington, D.C.: Government Printing Office, 1959), pp. 287–88.

Groves, as chairman of the Combined Development Trust, tended to dominate its activities. And in the Combined Policy Committee, Maj. Gen. Wilhelm D. Styer headed the important technical subcommittee, whose reports furnished much of the data for the parent committee's decisions on matters relating to Manhattan's production and weapons development program.[21]

The first important achievement for the United States and Great Britain was final agreement with the Belgians in early fall of 1944. As soon as the two countries had reached agreement in June on establishment of the Trust, General Groves and Sir Charles Hambro, acting on behalf of the Trust, began direct negotiations with Edgar Sengier to expedite arrangements with the African Metals Corporation for reopening Union Miniere's Shinkolobwe mine. The diplomatic negotiations finally culminated in the Belgian, or Tripartite, Agreement of 26 September, effected by an exchange of letters among Foreign Minister Paul H. Spaak of Belgium, Chancellor Anderson, and Ambassador Winant.[22]

Under terms of the agreement, Belgium granted the United States and the United Kingdom an option on all of its uranium and thorium resources in recognition of the fact that "the protection of civilization" required "effective control of said ores. . . ." The option was to continue in effect for the period needed to carry out ore contract arrangements set up under the agreement, as well as for an additional ten-year period. Belgium reserved the right to retain such ore as might be needed for "her own scientific research and . . . industrial purposes. . . ."[23]

But the two atomic partners did not secure this control over the Congo ore deposits without making some major concessions. President Roosevelt had approved the concessions in August 1944, harking to the advice of Stimson, who monitored the negotiations, that if they were not granted the Belgians might delay indefinitely reopening the Shinkolobwe mine. Of particular importance was the two allies' agreement to enter into a contract between the Trust and African Metals for purchase of 3.44 million pounds of uranium oxide under terms acceptable to the Belgian government. In addition, they also assented to furnish Union Miniere with the new equipment and materials it would require to reopen and operate the Shinkolobwe mine. Finally, they granted the Belgians the right to participate in any future utilization that might be made of the Congo ores "as a source of energy for commercial purposes. . . ." [24]

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[21] CPC Min, 8 Sep 43, HB Files, Fldr 9, MDR; CDT Prov Min, 14 Sep 44, OCG Files, Gen Corresp, MP Files, Fldr 9, Tab B, MDR.

[22] Ltrs, Spaak to Winant and Anderson, both 26 Sep 44, and Incl (Memo of Agreement); Ltrs, Anderson and Winant to Spaak, both 26 Sep 44. All in HB Files, Fldr 49, MDR. Extensive materials, including copies of correspondence, cables, notes of meetings, drafts and texts of agreements, relating to the Belgian Agreement and the arrangement with the African Metals Corporation are in HB Files, Fldrs 17, 54, 55, 57, 106, MDR, and in OCG Files, Gen Corresp, MP Files, Fldr 16, MDR. A brief description of the negotiations and an analysis of the agreements made may be found in Ms, "Diplomatic Hist of Manhattan Proj," pp. 17–18 and 25–26, HB Files, Fldr 111, MDR.

[23] Memo of Agreement, Incl to Ltrs, Spaak to Winant and Anderson, both 26 Sep 44, MDR.

Meantime, representatives of the Trust and African Metals, conferring in New York, had worked out the terms of the contract to cover the procurement of the 3.44 million pounds of uranium oxide. On 17 October, they signed the formal contract. It provided that the Trust would purchase only the oxide in the uranium ore, letting African Metals retain the radium and other precious metals contained in the concentrate. Reaching agreement on a fair price was difficult, for its value had never been determined on the open market and depended ultimately upon the success of the atomic bomb project. They finally settled upon a price based primarily on known cost factors—$1.45 a pound for high-grade material, five cents less for low grade, free on shipboard at the port of Africa (Lobito in Angola or Matadi in the Belgian Congo). Perhaps partly to compensate for any losses likely to result from the uncertainty as to a fair price, the Trust agreed to reimburse Union Miniere for costs it incurred up to $550,000 in reopening Shinkolobwe mine, and also to assist it in procuring materials, equipment, and skilled labor. With this assistance, Union Miniere, which already had taken preliminary steps for resumption of uranium mining operations in the Congo, estimated that it could begin delivery of new oxide to the Manhattan Project by late 1945 or early 1946. [25]

In anticipation of the heavy financial obligations that the Trust would have to meet under terms of the African Metals contract, as well as under other ore acquisition contracts that it expected to negotiate in the future, the American trustees had already taken steps to secure funds for payment of the United States' share of the cost of Trust operations. This had turned out to be a fairly complex problem, because the Trust's requirement for extreme secrecy and for continuous access to funds without time limitations to meet contractual obligations tended to run counter to legally established governmental fiscal procedures. General Groves had undertaken responsibility for coming up with a plan that would circumvent these legal barriers without impairing the contractual capabilities or security of Trust operations. Groves presented his plan to the Combined Policy Committee on 19 September 1944, emphasizing that the objectives of the agreement under which the Trust had been set up in the previous June made absolutely necessary an access to adequate funds. The committee unanimously endorsed the plan and Groves set about immediately to put it into effect. [26]

The essential feature of Groves's plan was a special fund to be deposited with the Department of the Treasury, from which he or other designated American members of the Trust could draw money as needed, without further authorization being required. Money from this fund would be placed in the Federal Reserve Bank in New York City to cover the United States' share of payments on Trust contracts. On 21 September, Under Secretary of War Robert P. Patterson directed allocation to Groves of an initial sum of $12.5 million from funds already appropriated for national defense purposes. By the time Groves received the check, however, his legal staff had found that funds deposited with the Treasury were subject to handling and processing by many employees in both the Treasury and the General Accounting Office, too great a security risk for the Manhattan Project. A possible alternative was to deposit the money directly in the Federal Reserve Bank in New York City or in a private banking institution in that city. But after further consultation with War Department lawyers and with Secretary Stimson and George Harrison, a fellow trustee, Groves concluded that probably not even this step could be taken without first informing Secretary of the Treasury Henry Morgenthau.

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[24] Ibid.; Memo, Stimson to President, 25 Aug 44, HB Files, Fldr 49, MDR.

[25] Ltr, Groves to Stimson, 24 Nov 44, HB Files, Fldr 27, MDR; CPC Min. 19 Sep 44, MDR; Groves, *Now It Can Be Told*, pp. 177-78.

[26] Groves had in mind paragraph 2 of the Agreement and Declaration of Trust, dated 13 Jun 44, which directed that the CDT should "gain control of and develop production of Uranium and Thorium supplies in certain areas . . . and for that purpose . . . take such steps as it may in the common interest think fit" to accomplish this objective. The original of this agreement is in HB Files, Fldr 13, MDR.

On 17 October, Groves and Harrison met with Stimson in his office to try to resolve the Trust's quandary over its funds. There appeared to be no legal way around the requirement that the Trust must secure the consent of Secretary Morgenthau before depositing the $12.5 million with the Treasury. Yet Stimson was convinced Morgenthau would insist on having full knowledge of the atomic bomb project before giving his consent. This, Stimson felt, he could not do without permission from the President, whom he did not wish to bother concerning such a relatively unimportant matter. Stimson finally was persuaded to attempt to get Morgenthau's sanction of the special fund without telling him the reason for its existence; but, as the Secretary of War had predicted, he refused. Fortunately, however, further negotiations between Manhattan District and Treasury officials revealed that Secretary Morgenthau maintained several accounts in his office which were not subject to the usual auditing and accounting procedures and that Trust funds might be placed in one of them without danger of exposure. Groves visited the Treasury Secretary on 27 October and, still without revealing the purpose, received permission to place Trust money in one of the special accounts. Henceforth, Groves made withdrawals from the account, depositing them in the Bankers Trust Company of New York to cover payments on the African Metals and other contracts. In the period from late 1944 until he resigned from the Trust at the end of 1947, the Manhattan commander deposited a total of $37.5 million in the Trust's Treasury account.[27]

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[27] The complex history of CDT financing may be traced in the following documents. Except as otherwise indicated, all items are in MDR, OCG Files, Gen Corresp, MP Files, Fldr 9, Tab B: CDT Prov Min, 14 Sep 44; Memos, Und Secy War to WD Budg Off, 21 Sep 44 and 4 Aug 45; Memos for File, Groves, both 17 Oct 44; Memo, Groves to Secy War, 27 Oct 44; Ltr, Daniel W. Bell (Act Secy Treas) to Groves, 30 Oct 44; Ltr, Groves, Harrison, and Leith to Sloan Colt (Bankers Trust Co. president), 15 Nov 44; Memo, Groves to Secy War, 6 Jun 45, HB Files, Fldr 37, MDR; Memo, Groves to Und Secy War, 4 Aug 45; Ltr, Groves to Fred M. Vinson (Secy Treas), 14 Aug 45; Memo, Groves to WD Budg Off, 24 Aug 45; Memo, Col Ernest C. Bomar

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In late 1944, the British were interested in devising a more comprehensive plan for a long-range procurement program for raw materials. They expressed a particular need for a study that would provide information on developing radioactive ore sources within British areas outside of Canada. At its 19 September meeting, the Combined Policy Committee agreed unanimously that the Trust should undertake a worldwide survey of current and potential sources of radioactive materials. Committee members also acknowledged the need for more data on requirements, but they emphasized the theoretical nature of scientific and technical information and the difficulty of obtaining accurate estimates. Nevertheless, the committee directed its technical subcommittee to investigate and report on the uranium required for a "unit explosive of specified energy . . ." and for the next stage in development of atomic weapons, as well as scientific and technical factors that might have an important effect on future ore requirements for atomic explosives.[28]

The technical subcommittee completed its report in mid-November; however, after hearing a brief oral summary of its contents in January 1945, the Combined Policy Committee laid it aside without further action. The committee followed a similar course with the Trust's ore survey, which Groves had sent to Stimson on 24 November. Although based upon more complete data from the Murray Hill Area Engineers Office sources compiled by Union Mines and from the British Directorate of Tube Alloys, the survey did not substantially alter the overall picture that Union Mines had depicted in its earlier reports submitted to the district engineer.[29]

As chairman of the Trust, General Groves made some specific recommendations based on data from the Trust's ore survey. The United States and Great Britain should continue investigation into uranium and thorium resources, organizing permanent survey groups in England and Canada similar to the Union Mines teams operating in the United States; every effort should be made to build up stockpiles in territories controlled by the two countries; major ore deposits outside these territories (for example, uranium in the Congo and thorium in Brazil) should be purchased and shipped for storage to areas under control of the two atomic powers; and lesser deposits (for example, in Portugal, Czechoslovakia, and Madagascar)

(Act WD Budg Off) to CG ASF, Attn: Office of Fiscal Dir (Col Foster), sub: CDT, 28 Aug 45, and 1st Ind, HQ ASF, Office of Fiscal Dir, fwd to Und Secy War, Attn: Col Freidlich, 30 Aug 45, HB Files, Fldr 51, MDR; Ltr, Groves to Secy Treas, sub: Termination of Account, 5 Dec 47; Ltr, E. F. Bartlet (Fiscal Asst Secy, Treas) to Groves, 8 Dec 47; Ltr, Groves to Secy Army, 8 Dec 47. See also Groves, *Now It Can Be Told*, pp. 176–77.

[28] Quoted phrase from CPC Min, 19 Sep 44, MDR. Memo, Sir Ronald I. Campbell (British CPC member) to CPC Joint Secys, sub: Development of Coordinated Prgms for Procurement of Raw Material for T(ube) A(lloys) Proj, 24 Aug 44; Ltr, Bundy and Webster to Styer, 2 Oct 44. Both in HB Files, Fldr 27, MDR.

[29] CPC Min, 22 Jan 45, HB Files, Fldr 14, MDR; Memo, Tech Subcommittee to CPC, sub: Ore Requirements for Prod of Explosives, 16 Nov 44, HB Files, Fldr 27, MDR; Chart (analysis of estimated requirements of uranium ore for each of several proposed types of atomic weapons), OCG Files, Gen Corresp, MP Files, Fldr 2, MDR; Rpt, CDT, sub: Survey of World's Resources of Uranium and Thorium, 26 Oct 44, Incl to Ltr, Groves to Stimson, 24 Nov 44, MDR.

should be brought under control by purchase or by political agreements. The United States and Great Britain endeavored to carry out most of these recommendations. Where political or diplomatic negotiations were required, action was taken through appropriate government channels. Where commercial agreements would suffice, the Trust initiated negotiations.[30]

The quest for other sources continued in 1945. Early in the year British officials began negotiations with the British and Portuguese owners of uranium mining properties in Portugal, preparing the way for their purchase by the Trust. At the end of January, Colonel Guarin, Manhattan's raw materials expert, returned from an extended inspection trip to the Congo with new information on the progress being made by Union Miniere in reopening the mines there, and as a result of his report, the Trust negotiated with African Metals for the purchase of more Congo ores that summer. Even the advancing Allied forces in Belgium, France, and Germany furnished additional small quantities of captured uranium ore stores.[31]

These seized stocks became a matter of slight disagreement between the United States and Great Britain. The Declaration of Trust provided that all uranium, or thorium, secured from whatever source was to be held jointly, but it was generally understood that the first objective of the atomic program in both countries must be to supply the American project with the raw materials it needed to develop and build sufficient atomic weapons to win the war. However, some British scientists felt that at least a part of the captured ore, which had been shipped from the Continent to England for temporary storage, ought to remain there to ensure that the British Tube Alloys project would have adequate supplies on hand. Groves disagreed. When he learned in June 1945 that ore captured in Germany was being held in Great Britain, he wrote Secretary Stimson and asked that the Combined Policy Committee request its prompt shipment to the United States "to increase our margin of safety of raw material." British committee members expressed concern that allocation of all of the ore to the United States would leave Great Britain with virtually no reserves at the end of the war. The committee, nevertheless, reaffirmed the policy that while the war lasted all raws materials received by the Trust, including that captured, should go to the United States for weapon production. At the same time, to placate British fears, the committee stated that if the Trust should acquire more than needed for the manufacture of weapons, it should hold it in reserve to be shared jointly after the war.[32]

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[30] Ltr, Groves to Stimson, 24 Nov 44, MDR.

[31] CPC Min, 22 Jan 45, Fldr 14; CPC Min, 8 Mar 45, Fldr 46 (copy in Fldr 105); CPC Min, 4 Jul 45, Fldr 37 (copy in Fldr 105); Ltr, Stimson to Secy State, 29 Jul 44, Fldr 7; Ms, "Diplomatic Hist of Manhattan Proj", pp. 31-32, Fldr 111. All in HB Files, MDR. Groves Diary, 29 Jan 45, LRG. Gowing, *Britain and Atomic Energy*, pp. 313-14.

[32] Quoted phrase from Memo, Groves to Stimson, 23 Jun 45, HB Files, Fldr 37, MDR. Agreement and Declaration of Trust, 13 Jun 44, Fldr 49; Rpt, CDT, sub: Survey of World's Resources of Uranium and Thorium, 26 Oct 44, Incl to Ltr, Groves to Stimson, 24 Nov 44, Fldr 27; CPC Min, 8 Mar 45, Fldr 46. All in HB Files, MDR.

Incoming mineral survey reports indicated that kolm, a coal-like material intermixed with oil shale deposits mined in Sweden, contained uranium. In early 1944, a British team and a group of Swedish mineral experts concluded that kolm's potentialities were sufficient to warrant denying other powers access to the mineral. At the request of the Combined Policy Committee, the American minister in Stockholm, Herschel V. Johnson, opened negotiations with the Swedes. The negotiations, conducted with the knowledge of the British minister in Stockholm, ended without a formal agreement. The Swedish government, however, prohibited export of uranium-bearing ores and agreed to inform the United States and Great Britain if in the future it should decide to permit their export.[33]

While the British gave full support to the program for control and acquisition of uranium, they were much less enthusiastic about a similar program for thorium. On 27 January 1945, British committee member Sir Ronald I. Campbell, who had replaced Col. John J. Llewellin, wrote to Stimson, expressing doubt as to the wisdom of Groves's suggestion that the Trust, without direct committee approval, should undertake measures that would likely require political agreements and trade options. In Sir Ronald's view, both the Combined Policy Committee and the two governments ought to have time to examine the implications of such negotiations before the Trust proceeded. Sir John Anderson advanced similar views, emphasizing that widespread occurrence of thorium limited the possibility that the United States and Great Britain could effectively prevent other nations from acquiring and purchasing substantial quantities of the material. He also suggested that, because limited amounts of thorium were needed in the immediate future, the two allies should rely upon the rather ample commercial production available from the Indian state of Travancore.

The United States, however, did not want to rely solely on British controlled thorium supplies and in mid-February proceeded—without informing the British government—to investigate acquisition of supplies outside of British-American control. In the meantime, Sir John had read Colonel Guarin's report on the obstacles to a rapid increase in uranium ore production from the Congo and also had learned of new information that emphasized the potential of thorium. Because of these developments, he agreed in early March to go along with a more vigorous policy on thorium. But he was overtaken by events, for the United States was already engaged in secret unilateral negotiations with Brazil to gain access to its thorium resources.[34]

Playing a significant role in laying the groundwork of these negotiations was General Groves, who was very much aware that most atomic scientists, including those in Germany and the Soviet Union, recognized that thorium might soon have to replace, or supplement, scarce uranium. When he learned Secretary of State Edward R. Stettinius, Jr., would be passing through Brazil in mid-February, en route from the Yalta Conference (3–11 February) to attend an inter-American meeting in Mexico City, he saw an opportunity to approach the Brazilians secretly. Taking advantage of a conference with the President on other matters, Groves requested and received permission to brief Stettinius on the atomic project. He subsequently talked with Stettinius and also arranged to have an officer from the Manhattan staff, Maj. John E. Vance, accompany the Secretary of State to Brazil.[35]

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[33] CPC Min, 4 Jul 45, Fldr 37; Draft of Proposed Agreement With Swedish Govt and Related Papers, Jul–Aug 45, Fldr 53; Ms, "Diplomatic Hist of Manhattan Proj," pp. 29–30, Fldr 111. All in HB Files, MDR. Gowing, *Britain and Atomic Energy*, p. 314.

[34] Ltr, Groves to Stimson, 24 Nov 44; Ltr, Campbell to Stimson, 27 Jan 45; Memo, sub: Supplies and Requirements for T(ube) A(lloys), 3 Mar 45 (addendum to memo giving Sir John Anderson's views, dated 3 Feb 45). All in HB Files, Fldr 27, MDR. Gowing, *Britain and Atomic Energy*, p. 316.

On 17 February, Stettinius conferred with President Getulio Vargas on the question of thorium and the Brazilian chief executive approved the opening of negotiations. In the ensuing months, specially appointed Brazilian and American delegations—the United States representatives included three Manhattan officers: Col. John Lansdale, Jr., Major Vance, and 1st Lt. Joseph Volpe, Jr.—worked out details of an agreement, signed on 6 July 1945. It provided that the United States would purchase each year for three years at least 3,000 tons of thorium-bearing monazite ore. In addition, the United States would have an option to buy all other thorium-bearing compounds Brazil might produce in the initial three-year period, with the right to renew this option for ten more successive three-year periods. The British had no knowledge of the agreement, but in September the United States agreed to the understanding reached earlier in March by the Combined Policy Committee that each country should have equal privileges in any arrangement for thorium acquisition and control made with Brazil.[36]

When the committee approved the start of negotiations with Brazil, it also endorsed taking steps to obtain control of thorium in India and in the Netherlands East Indies. The British began discussions with Travancore authorities in the summer of 1945, but the negotiations proved difficult and not until 1947 was a less than satisfactory agreement reached. Negotiations conducted at the same time with the Dutch concerning the East Indian sources were more successful, and in August 1945 an agreement granted thorium purchase options to the United States and Great Britain.[37]

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[35] Memo, Groves to Bundy, 6 Feb 45, HB Files, Fldr 27, MDR; Groves, *Now It Can Be Told*, p. 184.

[36] Memo, Groves to Bundy, 6 Feb 45, MDR; Memo, Groves to MPC, 23 Feb 45, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; Ltr, Groves to Secy War, 8 Mar 45, OCG Files, Gen Corresp, MP Files, Fldr 9, Tab B, MDR; CPC Min, 8 Mar 45, HB Files, Fldr 46, MDR; Ms, "Diplomatic Hist of Manhattan Proj," pp. 27–28 and Anns. 24–25, HB Files, Fldr 111, MDR; Gowing, *Britain and Atomic Energy*, p. 317.

[37] CPC Min, 8 Mar 45, Fldr 46; CPC Min, 4 Jul 45, Fldr 37; Memo, Groves to Stimson, 7 Jun 45, Fldr 37. All in HB Files, MDR. Gowing, *Britain and Atomic Energy*, pp. 317–18. Groves, *Now It Can Be Told*, p. 184.

CHAPTER XIV

The Feed Materials Program

The Manhattan District's acquisition of uranium- and thorium-bearing ores was only the initial step in providing the essential materials for the large-scale electromagnetic, diffusion, and pile processes.[1] The District also had to bring under contract and to monitor the operation of a complex network of processing plants for refining and converting the ore, first into pure concentrates of uranium oxide (black oxide) or sodium uranate (soda salt) and then into the chemical feed forms of uranium dioxide and trioxide, uranium tetrafluoride and hexafluoride, and uranium metal. Thus for the Army, development and management of the feed materials program, begun by the Office of Scientific Research and Development (OSRD) and Stone and Webster in 1941–42, proved to be one of its most challenging and difficult tasks in administering the atomic bomb project.[2]

Program Organization and Support Activities

With ore acquisition activities proceeding apace, District Engineer Marshall in October 1942 formed a Materials Section to monitor the shipment of uranium-bearing ores and other materials from mines, tailing piles, storage depots, and processing plants, as well as their treatment through various stages of refinement and conversion into feed materials. He selected Lt. Col. Thomas T. Crenshaw as section head and assigned several District officers already familiar with some aspect of materials procurement to assist him—including Capt. Phillip L. Merritt, a geologist by training, and Capt. John R. Ruhoff, a chemical engineer who, when serving as the St. Louis area engineer, had overall responsibility for the District's uranium metal production. Also, because of Colonel Nichols's deep involvement in the earlier OSRD acquisition progam, Marshall had his deputy continue to give his special attention and expertise to the District's feed materials program.[3]

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[1] Because thorium has fissionable properties similar to uranium, Manhattan Project leaders vigorously pushed a program to locate and control world resources of this heavy element. But existence of adequate supplies of uranium for the atomic bomb project made unnecessary procurement and processing of thorium during World War II.

[2] MDH, Bk. 7, Vol. 1, "Feed Materials and Special Procurement," pp. 1.1–1.5, DASA.

[3] Unless otherwise indicated, details on the administrative and personnel aspects of the feed materials program are based on ibid., pp. 1.15–1.22 and

Continued

The relocation of District headquarters from New York to Oak Ridge in mid-August 1943 occasioned a complete reorganization of the Materials Section. (*See Chart 2.*) Colonel Nichols, now the district engineer, decided to leave the materials group in New York City, close by the ports of entry and storage points for ores coming from overseas and also convenient to the headquarters of many of the firms under contract to supply feed materials. He redesignated the section as the Madison Square Area Engineers Office and, with transfer of Colonel Crenshaw to Oak Ridge as the officer in charge of all Clinton operations, assigned Ruhoff, recently promoted to lieutenant colonel, to be the Madison Square area engineer. Colonel Ruhoff took over administration of a burgeoning materials group, numbering nearly four hundred by early 1944, and an indication of its key role during the period of the project's greatest activity, from late 1943 to the fall of 1944, was Nichols's practice of coming to New York for weekly meetings with Ruhoff and his staff.[4]

The Madison Square staff, three-quarters of which worked in the New York City area and the rest at various points in the field, oversaw a program comprised essentially of four operations: a search for additional raw materials; their procurement in whatever form might be available; their refinement; and their conversion into feed materials. To ensure a steady flow of raw and semirefined materials to the project's processing plants, staff members closely monitored the scheduling of ore shipments from Africa to the port of New York; made or expedited arrangements for their storage; approved procurement of partially processed uranium-containing materials; and assisted in contracting with crude ore refining firms (African Metals Corporation, Eldorado Mining and Refining Company, and Vitro Manufacturing Company) to obtain uranium oxide, uranium sludge, radium and radioactive lead, and similar products. They also oversaw various research programs (Princeton and Yale Universities, Massachusetts Institute of Technology, and National Bureau of Standards), supplying them with an ever-increasing variety of other chemicals and special materials.

Staff members in the field provided liaison between the Madison Square office and seven area offices reporting to Ruhoff (*Chart 4*). Of these, two—the Murray Hill Area Engineers Office in New York and the Colorado Area Engineers Office in Grand Junction—monitored materials procurement, while five—Iowa (in Ames), St. Louis, Wilmington, Beverly (near Boston), and Tonawanda (near Buffalo)—oversaw feed materials processing oper-

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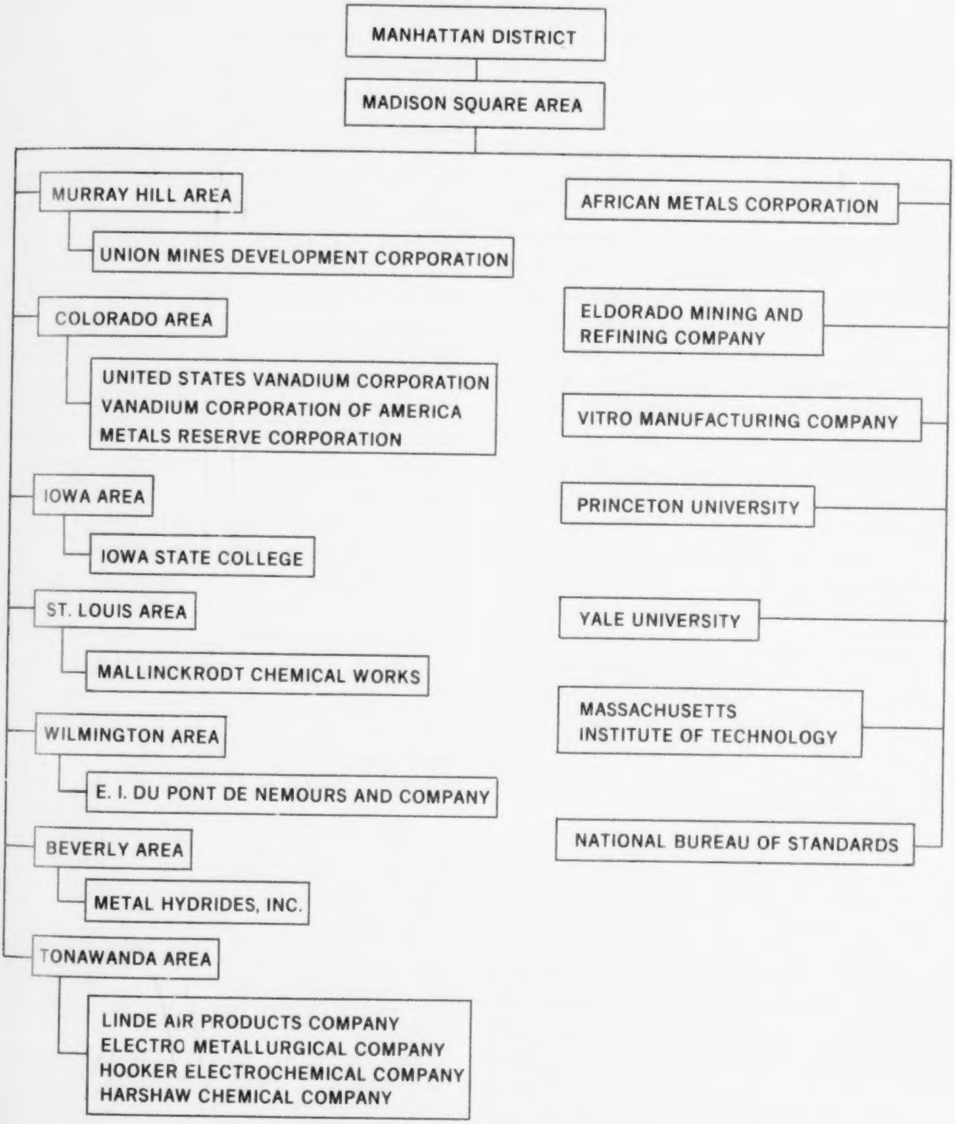
Apps. B1–B4 (Org Charts), DASA; Rpts, Mat Sec (later Mad Sq Area Engrs Office), Oct 42–Aug 45, passim, MD-319.1 (Rpts MSA), OROO. The period covered in these reports on the materials program varies from a single week to two months. The newly organized Materials Section on 28 Oct 42 submitted its first report to the district engineer for Colonel Nichols's attention, and the reconstituted Madison Square Area Engineers Office on 6 Aug 43 submitted its first report through Lt. Col. E. H. Marsden, executive officer at the new District headquarters in Tennessee, for the attention of the district engineer.

[4] Rpt, Mad Sq Area Engrs Office, 29 Apr 44, App. 3, OROO; Nichols, Comments on Draft Hist "Manhattan," Incl to Ltr, Nichols to Chief of Mil Hist, 25 Mar 74, CMH. Nichols arrived at the new designation of the area office because of its location near Madison Square, at Fifth Avenue and Twenty-third Street.

CHART 4—FEED MATERIALS NETWORK, JANUARY 1945


MANHATTAN DISTRICT
MADISON SQUARE AREA
MURRAY HILL AREA
UNION MINES DEVELOPMENT CORPORATION
COLORADO AREA
UNITED STATES VANADIUM CORPORATION
VANADIUM CORPORATION OF AMERICA
METALS RESERVE CORPORATION
IOWA AREA
IOWA STATE COLLEGE
ST. LOUIS AREA
MALLINCKRODT CHEMICAL WORKS
WILMINGTON AREA
E. I. DU PONT DE NEMOURS AND COMPANY
BEVERLY AREA
METAL HYDRIDES, INC.
TONAWANDA AREA
LINDE AIR PRODUCTS COMPANY
ELECTRO METALLURGICAL COMPANY
HOOKER ELECTROCHEMICAL COMPANY
HARSHAW CHEMICAL COMPANY
AFRICAN METALS CORPORATION
ELDORADO MINING AND REFINING COMPANY
VITRO MANUFACTURING COMPANY
PRINCETON UNIVERSITY
YALE UNIVERSITY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
NATIONAL BUREAU OF STANDARDS

Source: MDH, Bk. 7, Vol. 1, App. B4, DASA.

ations. A single area engineer administered the Iowa and St. Louis offices, traveling between the headquarters located at Iowa State College and the Mallinckrodt Chemical Works. In Wilmington, the busy area engineer at Du Pont kept a check on that firm's production of feed materials in addition to overseeing its plutonium program. In Beverly, the area engineer supervised the District's contract for uranium metal production with Metal Hydrides, Inc. And in Tonawanda, the area engineer had responsibility for contracts with the Linde Air Products Company, a subsidiary of the Union Carbide and Carbon Corporation, for production and chemical processing of uranium oxide into its dioxide and salt forms and with the Electro Metallurgical Company for production of uranium metal; later he supervised contracts with the Harshaw Chemical Company of Cleveland, which made uranium tetrafluoride and uranium hexafluoride, and with the Hooker Electrochemical Company of Niagara Falls, New York, which reclaimed uranium from slag produced in the mining of carnotite and other ores.[5]

Feed Materials Procurement

Raw Materials

From 1943 to the end of the war the Manhattan Project steadily increased its supplies of uranium ore, to ensure sufficient stores for conversion into the black oxide needed for the feed materials processing plants. Ore procurement activities, which reached a high point in 1944 and then leveled off somewhat in early 1945, were concentrated in three major areas: Africa, Canada, and the United States. Project leaders were aware in 1943 that the wartime needs of the bomb program were likely to exhaust both the immediately available domestic and Canadian deposits, and the security implications of this situation ultimately led to a District policy of using, to the greatest extent possible, ore from foreign sources.[6]

The most significant foreign source of natural uranium was the Belgian Congo, where the Belgian mining firm, Union Miniere du Haut Katanga, controlled all mineral rights. Following negotiations, the District procured the African ore through Union Miniere's subsidiary, the African Metals Corporation. For the period October 1942 to December 1944, cost of 30,000 tons of Congo ore containing 3,800 tons of black oxide totaled more than $9 million, based on the price of oxide averaging about $1.12 per pound. The District's Washington Liaison Office arranged for purchase of additional Congo ore, containing more than 3,100 tons of oxide and costing more than $10 million.[7]

All Canadian ore, procured through the Eldorado Mining and Refining Company (formerly, until June 1943,

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[5] MDH, Bk. 7, Vol. 1, pp. 2.1–6.3 and App. 11, DASA. List, sub: MD Contracts With Various Univs, Incl to Memo, Marsden to Groves, 2 Nov 43; List, sub: Signed Prime and Subcontracts Over $100,000, Incl to Memo, Marsden to Groves, 31 Aug 43. Both in Admin Files, Gen Corresp, 161, MDR.

[6] MPC Rpt, 21 Aug 43, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab E, MDR; U.S. Engrs Office, Mad Sq Area, sub: Notes on . . . Ltr to Sen [Edwin C.] Johnson [Colo.], 5 Dec 45, Admin Files, Gen Corresp, 312.1, MDR.

[7] Data on uranium ore purchases in this and subsequent paragraphs based on charts in MDH, Bk. 7, Vol. 1, Apps. F1–F3, DASA.

Eldorado Gold Mines), came from the Great Bear Lake area. In May 1943, with completion of Stone and Webster's initial purchase order (15 July 1942), the District negotiated another contract with a representative of Eldorado's sales agency in the United States. But procurement officials soon experienced serious difficulties in implementing this contract and decided to terminate it. Colonel Ruhoff, acting in his capacity as chief of the newly constituted Madison Square Area Engineers Office, agreed in September to the terms of a new contract with Eldorado; he approved a second agreement in December 1944. For the period July 1942 to December 1944, cost of 4,200 tons of Canadian ore containing 1,137 tons of black oxide was slightly over $6.6 million, based on the price of oxide varying from about $1.95 to over $4.00 per pound.[8]

Domestic sources of natural uranium were in the Colorado Plateau region of the states of Colorado, Utah, and New Mexico. The uranium in this region occurred in carnotite ores, which also contained vanadium—an element urgently needed in the war effort because of its use as a hardening agent in the manufacture of steel. District procurement officials, learning in late 1942 that those firms actively mining carnotite ores and refining vanadium did not extract the relatively small amount of uranium in the refuse materials, began negotiations in early 1943 to acquire these tailings. Because these tailings were in the form of sand, and thus too heavy for economical shipment, they arranged contracts with several vanadium operators—the government-owned and -financed Metals Reserve Corporation,[9] the privately owned and operated Vanadium Corporation of America, and the United States Vanadium Corporation, a Union Carbide subsidiary—and proposed they convert the tailings into concentrates (sludges). The advantage of the concentrates was that they would yield a higher percentage of uranium for conversion into black oxide and that, in this form, shipment to the Buffalo-area processing firms would be a less costly operation. For the period November 1942 to February 1945, cost of 380,000 tons of carnotite sands containing 1,350 tons of black oxide was more than $2.1 million, based on the price of oxide averaging about $0.80 per pound.[10]

Uranium ore from North America yielded considerably less black oxide than that from Africa, primarily because of the much greater oxide content of the latter. The African ore from the Belgian Congo contained an estimated average of over 2-percent black oxide, whereas Canadian ore from the Great Bear Lake area assayed at somewhat more than 0.5 percent and domestic ore from the Colorado Plateau region at 0.25 percent. For this reason, the combined quantity of estimated black oxide in uranium ore purchased from the North American sources accounted for only one-third of the total contracted for the entire project.[11]

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[8] Ibid., pp. 3.1–3.3 and App. F2, DASA; MPC Min (and attached documents), 24 Feb 45, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; Memo, 1st Lt Winston H. Pickett (Intel & Scty Div) to Groves, sub: Contract Disclosure in Current Canadian Case (Relating to Ore Supply Prgm in WW II), 15 Mar 46, Investigation Files, Gen Corresp, Boris Pregel, MDR.

[9] The Metals Reserve Corporation, a subsidiary of the Reconstruction Finance Corporation, was established under legislation enacted by Congress in 1940, with the objective of providing for purchases of strategic and critical materials. By late 1944, Metals Reserve, which Congress had supplied with adequate funds and power to procure items needed by war industries and for stockpiling, had spent some $1.7 billion for 19 million tons of materials. See Smith, *The Army and Economic Mobilization*, pp. 203–04.

[10] MDH, Bk. 7, Vol. 1, pp. 4.1–4.8, 7.8–7.13, App. F3, DASA; Memo, Merritt to Nichols, sub: Resume of Production of Uranium Products for MD in Colorado Plateau Area, 26 Jan 45, Admin Files, Gen Corresp, 410.2 (Uranium), MDR; Rpts, Mat Sec (later Mad Sq Area Engrs Office), 3 Jul–13 Aug 43, OROO.

Special Materials

So tremendously important to the success of the atomic project was securing and processing raw ores that this operation tended to obscure another significant activity of the District's feed materials program: procurement of special materials. A number of these materials were difficult to obtain in the quantities needed or completely unavilable from commercial sources. Hence, their procurement was often not simply a matter of District officials approving a purchase order or letting a contract, but required planning and implementing means for the radical expansion of such limited sources as existed or for even approving construction of entirely new plants. Two separate sections in the Madison Square Area Engineers Office had responsibility for special procurement—the Special Materials Branch and the Special Projects Branch.[12]

Demands for special chemicals and other materials of the project's research and production facilities increased rapidly in 1943 and 1944. For testing and operating atomic piles there was need for radium and radioactive lead as a neutron source, graphite and beryllium as neutron moderators, and helium as a coolant; for the heavy water project at Trail, nickel chromium for a catalyst; for the gaseous diffusion project, elemental flourine and a variety of fluorinated chemicals, including those suitable for cleaning, cooling, lubricating, and sealing; for the manufacture of uranium metal, magnesium and calcium; and for the design and test of the bomb at Los Alamos, a seemingly endless list of materials—bismuth, tungsten, boron, beryllium, and many others.

The quantity and variety of special materials needed by the project presented the Madison Square staff with a whole spectrum of challenging problems. Some proved to be relatively simple. For example, radium and radioactive lead, which were byproducts of uranium processing, could be obtained from the same firms that refined the ore. In the early period, project officials purchased most of the radium required through the New York firm, Canadian Radium and Uranium Corporation, which procured most of its supply from Eldorado Mining and Refining. In 1943, however, difficulties in reaching agreement on contractual terms and prices caused them to turn to Joseph A. Kelly, who acted as agent for the Radium Chemical Company of New York. After 1943, Kelly supplied most of the radium required by the project. As for radioactive lead, the District obtained most of its requirement for this material from Eldorado Mining's ore-refining operations at Port Hope, Ontario.[13]

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[11] MDH, Bk. 7, Vol. 2, "Geographical Exploration," pp. 1.6–1.7, DASA.

[12] MDH, Bk. 7, Vol. 1, pp. 1.9, 6.1, Apps. B and G–K (see charts), DASA.

Acquisition of a suitable pile moderator was one of the most difficult procurement problems in the early months of the project's plutonium program. Pile designers finally decided to employ graphite rather than heavy water or beryllium, because it was the only one of these neutron-absorbing substances available in quantity from commercial sources and because Metallurgical Laboratory scientists and researchers at the National Carbon and Speer Carbon Companies recently had devised a process that would produce an adequate supply of high-grade graphite for the program. This success with graphite did not, however, end interest in obtaining beryllium and heavy water for experimental purposes. Project scientists, particularly those at Los Alamos, showed an increasing interest in beryllium metal in the later years of the war. Only a single American firm, Brush Beryllium Company of Lorain, Ohio, produced beryllium commercially for the fabrication of certain alloys. From 1943 to 1946, the Madison Square staff concentrated its efforts on increasing the production capacity of this firm, assisting it in obtaining priorities on new equipment and other materials from the War Production Board and also in expanding its plant. By 1945, these measures had led to a substantial increase in production of beryllium metal.[14]

Generally speaking, District procurement officials had to cope with no more than the usual stringencies of the tight wartime economy in obtaining moderate quantities of such elements as magnesium, calcium, bismuth, tungsten, boron, and helium. Because early decisions for helium-cooled production piles appeared to forecast a future need for very large amounts of the gaseous element, they arranged with the Bureau of Mines, which controlled helium distribution, for large-scale procurement, including transfer directly of funds from the War Department to Interior to pay the costs. In 1943, they also assisted in negotiation of a contract with the General American Transportation Company of Chicago for purchase of special tank cars to ship the helium to Hanford. But the decision by pile designers later that year to use water as the primary coolant greatly reduced the need for helium, and the District materials group sharply cut back the earliest procurement schedules for the element.[15]

Another material that presented special procurement problems was elemental fluorine, to include its chemical derivatives. This highly corrosive, and therefore hazardous-to-handle, element was the choice of the project designers for combining with uranium to make the gaseous feed material (uranium hexafluoride) for operating several of the main production plants. Because of the huge requirements of just the gaseous diffusion plant, as well as the problems of shipment, the designers decided to build a fluorine gas production plant right at the diffusion plant site. The District's materials group also played a significant role in letting contracts and overseeing the activities of a number of private research institutions (Johns Hopkins, MIT, Purdue) and chemical firms (American Cyanamid, Du Pont, General Chemical, Harshaw Chemical, Hooker Electrochemical, Kinetic Chemicals, Penn Salt) in the development and supply of the numerous fluorinated hydrocarbon chemical compounds—in the form of coolants, sealants, and lubricants—needed to operate the plants safely and efficiently with the highly corrosive feed material.[16]

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[13] Ibid., pp. 6.1–6.3 and Apps. F5–F6, DASA.

[14] Ibid., App. K, DASA; Rpt, Ruhoff, sub: Mat Developments for 11–27 Oct 42, 27 Oct 42, MD-319.1 (Rpts MSA), OROO; Rpts, Mat Sec (later Mad Sq Area Engrs Office), 9 Nov 42, 6 and 13 Aug 43, OROO; Smyth *Report*, p. 65.

[15] MDH, Bk. 7, Vol. 1, App. I, DASA; List, sub: Signed Prime and Subcontracts Over $100,000, Incl to Memo, Marsden to Groves, 31 Aug 43, MDR.

Feed Materials Production

The initial phase of the feed materials production network was conversion of the uranium-bearing crude ore into pure concentrates of black oxide and soda salt by various industrial firms under contract to the District. In each case the refining treatment was quite similar and involved subjecting the crude ore to the successive processes of pulverization into a sandlike material, acid immersion, precipitation to eliminate impurities, and roasting (drying).

Eldorado Mining at its Port Hope refinery processed all Canadian ore and some Congo ore into black oxide, whereas the Vitro Manufacturing Company at its Cannonsburg (Pennsylvania) refinery processed only Congo ore into soda salt. Designed only for treating the higher-grade Congo and Canadian ores, neither the Eldorado nor Vitro plants could properly process the carnotite concentrates from the Colorado Plateau region. Aware that the Linde Air Products Company had produced for the OSRD a satisfactory grade of black oxide from carnotite concentrates, the District's Materials Section at the end of 1942 made arrangements with Linde to refine new stocks of concentrates at its plant in Tonawanda, New York, as well as to produce other feed materials for the project. With assistance of the Tonawanda area engineer, Linde expanded its black oxide production facilities, but, by late 1943, was phasing out domestic ores and using its facilities to refine higher-yielding African ores.[17]

Figures compiled by the Madison Square Area Engineers Office, beginning in September 1943, show that the amount of uranium from all sources available for refinement in the United States and Canada, and the quantity of black oxide and soda salt extracted from this ore, grew dramatically from 1943 to 1945. Thus, at the end of September 1943, the Manhattan District had available 2,920 tons of uranium ore and produced 1,660 tons of black oxide and soda salt. A year later, the quantities rose to 5,640 tons available and 3,500 tons of black oxide and soda salt produced. And at the close of September 1945, the figures stood respectively at 6,600 tons of ore and 5,150 tons of black oxide and soda salt.[18]

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[16] MDH, Bk. 7, Vol. 1, App. K, DASA; List, sub: Contracts To Be Taken Over by MD, Incl to Ltr, H. T. Wensel (Tech Aide, OSRD) to Marshall, 20 Mar 43, Admin Files, Gen Corresp, 161, MDR; List, sub: MD Contracts With Various Univs, Incl to Memo, Marsden to Groves, 2 Nov 43, MDR.

[17] MDH, Bk. 7, Vol. 1, pp. 1.20, 7.1–7.8, Apps. C–1A and F7, DASA. Details of early development of black oxide production by Linde in 1942–43 may be followed in Rpts, Mat Sec (later Mad Sq Area Engrs Office), Oct 42–Aug 43, 30 Oct, 30 Nov, and 31 Dec 43, 29 Jan 44, OROO.

The final phase in the feed materials production network was the conversion of black oxide and soda salt, through a series of chemical treatments, into one of the several chemical feeds suitable for processing in the electromagnetic, diffusion, and pile plants. The first step changed black oxide or soda salt into brown oxide (uranium dioxide) or orange oxide (uranium trioxide), the latter an important feed material for the electromagnetic process in its early stages of development. The second step transformed brown oxide into green salt (uranium tetrafluoride). The third, and final, step converted green salt into one of a number of uranium compounds—for example, gaseous uranium hexafluoride for the gaseous and liquid diffusion processes and the electromagnetic process in its last stage of development—or into uranium metal, the prime feed material for the pile process.[19]

Because the OSRD had made considerable progress in arranging contracts with industrial firms to provide for each of the different chemical treatments required to produce feed materials, the principal task remaining for Manhattan leaders was that of shaping the project's feed materials processors into a production network capable of supplying most of the feeds for the Clinton and Hanford production plants, regardless of the adverse effects of sabotage, technical failures, or other inhibiting factors. By early 1943, having extended OSRD contracts and negotiated new agreements, they organized and expanded this network so that, in effect, it comprised three parallel chemical-processing chains, the first link in each chain consisting of processors of both brown and orange oxide; the second, those of green salt; and the third, those of uranium metal.[20]

Mallinckrodt, Du Pont, and Linde comprised the brown and orange oxide links. Mallinckrodt, which had pioneered in development of the highly efficient ether process for refining uranium under the leadership of Ruhoff, provided the most important link. During the course of the wartime project, it produced nearly 4,200 tons of brown and orange oxide, nearly twice the output of the other two firms, and including almost all of the oxide used by the electromagnetic project. In cooperation with Yale University, it continued research that culminated in design and construction of a plant for continuous extraction of brown oxide from raw ore (pitchblende), not completed until 1946. The Du Pont plant, built adjacent to the company's big Chambers Chemical and Dye Works across the Delaware River from Wilmington in Deep Water, New Jersey, processed mainly scrap and by-products material to produce almost 2,000 tons of brown oxide. Linde, operating the third plant, processed black oxide from its own refinery to produce a total of about 300 tons of brown oxide.[21]

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[18] Rpts, Mad Sq Area Engrs Office, 30 Oct 43, 31 Oct 44, 29 Nov 45, OROO.

[19] Ibid., Sep–Dec 43, OROO; MDH, Bk. 7, Vol. 1, pp. 8.1–10.10, DASA.

[20] See Ch. I on the origins in the atomic bomb program of the idea of parallel production chains, characterized as a nuclear steeplechase involving various methods for producing fissionable materials. List, sub: S–1 Contracts, Incl to Ltr, Irvin Stewart (Ex Secy, OSRD) to Groves, 14 Dec 45, Admin Files, Gen Corresp, 161 (S–1 Contracts), MDR; MDH, Bk. 7, Vol. 1, pp. S10–S13 and App. F8, DASA.

Four chemical firms comprised the green salt links. Three were the same firms that produced brown oxide and the fourth was the Harshaw Chemical Company of Cleveland, which the OSRD had originally brought under contract to produce green salt in the summer of 1942. District procurement officials drew up new contracts for a substantially enlarged output in the fall of 1942—with Harshaw in September and the other three companies in November. These contracts, except for that with Harshaw, remained in effect for the duration of the war and resulted in production of more than 7,200 tons of green salt: 2,926 by Mallinckrodt, 2,060 by Linde, 1,640 by Harshaw, and 608 by Du Pont. When more uranium hexafluoride was needed for the diffusion plants, the Madison Square Area Engineers Office renegotiated the contract with Harshaw, providing in a new agreement that the Cleveland firm convert black oxide into green salt and then into uranium hexafluoride. At the same time, the Madison Square office also arranged to have Harshaw raise its output of uranium tetrachloride, which it had been producing in small quantities since early 1943, to meet a sudden increase in demand for the electromagnetic production plan.[22]

Four commercial firms and a college formed the uranium metal links. Mallinckrodt, Du Pont, Electro Metallurgical, Metal Hydrides and Iowa State, at one time or another, were involved in metal production for the wartime atomic project, although only the first three firms constituted the permanent links in the parallel feed materials chains. Uranium metal procurement dated back to the earliest days of the atomic energy program, because the material was required for laboratory research and experimentation. Both the National Bureau of Standards and the OSRD had let contracts to university research laboratories and commercial chemical firms to develop a process for mass production of uranium metal of a high degree of purity. The processes devised by Metal Hydrides proved to have serious drawbacks. Iowa State, however, had developed a method for reducing green salt with calcium (later, magnesium proved more effective) at high temperatures inside a steel bomb and recasting the end product into metal in an induction-heated furnace. So successful was this method that Iowa State itself employed it to manufacture a considerable amount of metal for the project. Subsequently, the Army let contracts to Mallinckrodt, Du Pont, and Electro Metallurgical to produce metal using the steel bomb method.[23]

When the Army took over direction of materials procurement, it continued the metal-production contracts with Metal Hydrides and Iowa State and negotiated new contracts with Electro Metallurgical and Du Pont. In several instances, District officials had to monitor construction of additional plant buildings, at government expense, to expedite the production of uranium metal under these contracts. Metal Hydrides and Du Pont had serious operating problems that limited their output of metal, although Metal Hydrides subsequently developed a highly successful metal-recasting operation. Nevertheless, by the time District officials shut down most production of new metal in late 1943—Iowa State continued its output until late 1944—the various contractors had manufactured several thousand tons. By late August 1944, the Madison Square area engineer reported delivery of nearly 3,500 tons of metal to Hanford and Clinton, comprised of 1,000 tons from Electro Metallurgical, 900 from Iowa State, 650 from Mallinckrodt, 610 from Metal Hydrides, and lesser amounts from other processors. These deliveries included both new metal and metal recast into ingots from turnings and other scraps from machining and fabricating operations.[24]

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[21] MDH, Bk. 7, Vol. 1, pp. 8.1–8.7, DASA.

[22] Ibid., pp. 9.1–9.9 and App. F8, DASA; Rpts, Mad Sq Area Engrs Office, 31 Oct and 30 Dec 44, 31 Jan 45, OROO.

[23] MDH, Bk. 7, Vol. 1, pp. 10.1–10.9, DASA. See also Ch. III.

Quality Control Program

One factor that made materials procurement difficult was the almost universal requirement for previously unheard of standards of quality. In the feed materials program, for example, procurement schedules required that uranium metal contain no more than 0.1 of 1 percent of impurities that would affect its efficiency in the pile-operating process. Similarly stringent standards were established for graphite, fluorinated chemicals, and other materials. Because most of the commercial contractors who furnished these materials were unprepared to carry out the physical and analytical tests necessary to maintain these high standards, the materials group had to build up its own quality control organization.[25]

In February 1943, Colonel Crenshaw's staff began negotiations with Princeton, MIT, the chemical section of the Metallurgical Laboratory, and the National Bureau of Standards, with the objective of forming these research institutions into a central quality control laboratory group. The plan was to have the scientists at each institution analyze and test samples from the uranium metal production plants, as well as to devise more effective methods of metal analysis, to furnish personnel and facilities when needed to supplement those of the manufacturing plants, to investigate other materials, and to provide general guidance for the control program. In addition, the Metallurgical Laboratory was to carry out physical tests of brown oxide and finished metal for the pile process. Because all of these institutions already were engaged in some aspect of analysis and testing of uranium, the Materials Section simply supplemented or revised existing contracts with them to provide the necessary organization of the central quality control laboratory group.[26]

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[24] Ibid., pp. 10.2-10.9 and App. F8, DASA; Rpts, Mat Sec (later Mad Sq Area Engrs Office), Sep-Dec 42 and 31 Aug 45, OROO.

[25] MDH, Bk. 7, Vol. 1, pp. 12.1 and App. G, DASA; Rpts, Mat Sec, 15 Feb and 4 Mar 43, OROO.

By spring, the Materials Section had completed satisfactory arrangements with Princeton, MIT, and the Bureau of Standards. Colonel Crenshaw reported in May that these three institutions were "doing an excellent job, and have attacked the problem as a job of commercial analysis, which is the case." [27] The Metallurgical Laboratory expressed a preference for carrying out its part of the analytical work under its existing overall research contract, but Crenshaw opposed this, because he knew it would prevent the Materials Section from exercising direct control over the laboratory's part in the analytical program. The reasons why the laboratory did not want such a contract soon became apparent: The scientists did not relish performing routine analysis and testing of metal samples because it took time and used facilities they would rather devote to more original and challenging research and development activities.[28]

Colonel Crenshaw arranged a meeting with Richard L. Doan, associate director of the University of Chicago's Clinton Laboratories in Tennessee, and George E. Boyd, chief of the analytical chemistry group at the Metallurgical Laboratory. The two scientists agreed that the Metallurgical Laboratory would continue to perform routine chemical analysis and testing of brown oxide and uranium metal until the workload in this area declined. This would occur shortly they knew, when Iowa State completed facilities for quality testing its own metal output. By fall of 1943, the other institutions had taken over mos of the routine chemical analytica work that the Metallurgical Laboratory had been doing. The Madison Square area engineer attested to the effectiveness of the quality contro program when, at the end of November, he reported to Colonel Nichols that the feed materials program was making metal of a higher degree o purity than any previously produced by the atomic energy project.[29]

Development of the feed materials program ahead of the fissionable materials production and weapon programs was a matter of necessity, for the latter were completely dependent upon an adequate supply of the feed and other materials essential to their operation. In less than two years, the Manhattan District's materials organization was able to expand the already existing OSRD program, solving serious technical problems and securing the requisite priorities to meet on schedule the requirements for the research and development, testing, and start-up in operations of the major production plants for the manufacture of fissionable materials. By late 1944 and in 1945, the District could begin to phase out, or reduce, some aspects of the program and to give some attention to the postwar requirements of the atomic energy program.

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[26] MDH, Bk. 7, Vol. 1, pp. 12.1–12.2, DASA; Rpts, Mat Sec, 15 Feb and 3 Apr 43, OROO; Cochrane, *Measures for Progress*, p. 383.

[27] Rpt, Mat Sec, 18 May 43, OROO.

[28] Ibid., 3 Apr, 4 and 18 May, 5 Jun 43, OROO.

[29] MDH, Bk. 7, Vol. 1, pp. 12.2–12.4, DASA; Rpts, Mat Sec (later Mad Sq Area Engrs Office), 18 Jun and 30 Nov 43, OROO.

CHAPTER XV

Land Acquisition

During the war the Manhattan District assembled extensive real estate holdings for its principal installations in Tennessee, New Mexico, and Washington State, as well as smaller tracts for its support facilities in other places, totaling more than 500,000 acres. Manhattan acquired most of this land, at least up to the point of occupancy, during the period September 1942 to August 1943; however, because of unavoidable legal delays in closing out procurement of original sites and recurring demands for additional space, it continued to be involved in some acquisition activities through September 1945.[1]

Land acquisition for the atomic energy project presented special problems hitherto never encountered by War Department agencies in their World War II real estate procurement programs. The Manhattan Project required absolute secrecy and unheard of speed in acquiring the needed sites. Yet these essential objectives were, in fact, inherently self-defeating, for land acquisition activities tended to attract widespread public attention and measures to expedite quick settlements tended to conflict with those for maximum secrecy. Nonetheless, convinced that the ultimate success of the project was at stake, Manhattan officials persisted in enforcing strict security measures, even though the latter produced a far-reaching tide of local opposition at the Tennessee and Washington sites.[2]

Clinton Engineer Works

The District's acquisition program in Tennessee officially began on 29 September 1942,[3] when Under Secretary of War Robert P. Patterson approved Maj. Gen. Eugene Reybold's letter directive requesting procurement of land for the Kingston Demolition Range, so-called for security reasons but in January 1943 officially redesignated the Clinton Engineer Works (CEW).[4] *(See Map 3.)* Under terms of this directive, the Engineers chief had official authorization to purchase approximately 56,200 acres[5] (*Table 2*), primarily in eastern Tennessee's Roane and Anderson Counties, using money appropriated from the Engineer Service–Army category of available funds.

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[1] Site selection for the major Manhattan installations is discussed in detail in Chs. III–V.

[2] Smith, *The Army and Economic Mobilization*, pp. 441–42; *U.S. Statutes at Large*, 1942, Vol. 56, Pt. 1, Second War Powers Act, Title II, p. 177; MDH, Bk. 4, Vol. 4, "Land Acquisition, Hanford Engineer Works," pp. 4.19–4.20, DASA.

[3] Except as otherwise indicated, facts and figures pertaining to the Tennessee land acquisition program are drawn from MDH, Bk. 1, Vol. 10, "Land Acquisition CEW," and from the appendices to that volume. Figures on the total acreage of the site and other statistics relating to the acquisition program are summarized on pp. 2.47–2.49. Many of the documents pertinent to the program are reproduced in App. B.

In anticipation of approval of this directive, the Engineers' ORD (Ohio River Division) Real Estate Branch on 28 September had opened a project office, designated the CEW Land Acquisition Section, at Harriman, a Roane County town a few miles west of the site. The ORD staff began immediately to secure for the section the services of some fifty appraisers for the job of appraising an estimated 800–850 separate tracts. The fact that division personnel currently were involved in another large-scale acquisition program for the Dale Hollow Dam and Reservoir, situated on a branch of the Cumberland River near the Tennessee-Kentucky border, compounded the difficulty of their new task; however, they resolved the problem by arranging to borrow the appraisers, on a short-term basis, from several regional Federal Land Banks and from the Tennessee Valley Authority (TVA) real estate staff. In keeping with War Department practices of basing appraisals mainly on an estimate of prevailing property values as determined by a review of comparable sales, on interviews with owners, and on actual physical inspection of each tract, the appraisers were able to complete most of the work on the original site by the end of 1942.[6]

The directive of 29 September had authorized procurement of the original site by condemnation. This permitted not only immediate acquisition of those parts of the area needed for preliminary construction but also expedited acquisition of properties with defective titles. On 6 October (effective 7 October), the U.S. District Court for the Eastern District of Tennessee, Northern Division, issued an order of possession at the request of ORD Real Estate Branch attorneys. The court took cognizance of the hardship to landowners facing remov-

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[4] Ltr, Robins (Act Chief of Engrs) to CG SOS, sub: Acquisition in Fee of Approx 56,200 Acres of Land for Demolition Range Near Kingston, Tenn., and 2d Ind (directive approval), Col Marion Rushton (Asst Ex, Office of Und Secy War) to Chief of Engrs, both 29 Sep 42, Incls to Memo, Col John J. O'Brien (CE Real Estate Br chief) to Lt Col Whitney Ashbridge (CE Mil Constr Br), sub: Land Acquisition in Connection With MD, 17 Apr 43, Admin Files, Gen Corresp, 601 (Santa Fe), MDR. The town of Kingston was located about 7 miles southwest of the site area.

[5] Acquisition of ten additional parcels of land, authorized in subsequent directives issued from June 1943 through August 1944, brought the District's real estate holdings to a total of approximately 58,900 acres. These parcels of land were mostly small tracts required for the adequate development and protection of the original site. *(See Map 3.)* Several tracts were secured to facilitate development of the transportation network, notably 70 acres in July 1943 for the right of way of a spur track built from the Southern Railway at Blair south along Oxier Creek to the north boundary of the original site. The largest additions were made in 1944, when the gaseous diffusion plant on the Clinch River at the western end of the reservation needed more ground. In April of that year the TVA granted the District a temporary-use permit for some 279 acres, and in August the CEW Land Acquisition Section acquired another 2,800 acres, consisting chiefly of an elevated area along Black Oak Ridge needed to improve perimeter security near the gaseous diffusion plant.

[6] Ltr, Fred Morgan (CEW Land Acquisition Sec Proj Mgr) to Joseph G. Colgan (House Mil Affairs Committee investigator), 6 Aug 43, copy in MDH, Bk. 1, Vol. 10, App. B2i, DASA; Memo, Marshall to Groves, sub: Major MD Contracts, 27 Apr 43, Admin Files, Gen Corresp, 161, MDR; *Knoxville Journal*, 4 Feb 43.

TABLE 2—LAND ACQUISITION AT CEW, 1942–1944

Date of Directive	Acreage To Be Acquired[a]	Estimated Cost	Type of Control Acquired	Use or Purpose
29 Sep 42	56,200	$3,500,000	Outright purchase	Original site
14 Jun 43	15.1	1,750	Outright purchase	For protection and security
3 Jul 43	70	14,107	Outright purchase	Spur track right of way
15 Jul 43	3.73	400	Outright purchase	Channel diversion of Poplar Creek
25 Sep 43	47.7	3,740	Outright purchase	Borrow pit
5 Feb 44	62	14,600	Perpetual easement	Access road
3 Mar 44	17	5,100	Outright purchase	Access road
19 Apr 44	279		Temporary-use permit from TVA	Expansion of facilities
2 May 44	.89	200	Perpetual easement	Access road
	.3	100	Outright purchase	Access road
4 Aug 44	.32		Temporary-use permit from TVA	Access road
28 Aug 44	425		Temporary-use permit from TVA	Security
	2,375	170,000	Lease or outright purchase	Security

[a] Figures given here represent the amounts estimated in the real estate directive, the sum totaling about 59,500 acres. The actual acreage finally acquired was less, approximately 58,900 acres.

Source: MDH, Bk. 1, Vol. 10, pp. 1.3–1.4, 2.21–2.26, App. B1, DASA

al on short notice by limiting the government's right of immediate exclusive possession to those sections where it was "essential to full and complete development of the project. . . ."[7]

The Manhattan District did not take exclusive possession of any tracts for construction purposes before 15 November, although it had exercised right of entry at many points before that date. The CEW Land Acquisition Section requested that owners and tenants, most of whom were farmers, be prepared to vacate at various times between 1 December 1942 and 15 February 1943. In some instances, where immediate vacating would cause undue hardship, the District permitted landowners to stay on even beyond the 15 February date. The effectiveness of this lenient policy is attested to by the fact that project officials never had to resort to a court order to secure eviction of an owner from the Clinton site.

As soon as the ORD Real Estate Branch had assembled sufficient data to meet legal requirements concerning areas needed immediately for military construction, branch attorneys filed declarations of taking. They filed the first declaration on 20 November 1942, covering a segment comprised of 13 tracts. By mid-January 1943 declarations were on file for 184 tracts covering 9,614 acres and, by May, for 742 tracts constituting

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[7] Copies of the condemnation petition, 6 Oct 42, filed by U.S. Atty James B. Prexier, Jr. et al., and the order of possession (source of quotation), 6 Oct 42, signed by Judge George C. Taylor, in MDH, Bk. 1, Vol. 10, App. G7, DASA.

FARM AT THE TENNESSEE SITE, *typical of those acquired by the Manhattan District*

53,334 acres—or nearly all privately owned property of the original site. Meanwhile, during the winter and spring of 1943, CEW Land Acquisition Section negotiators had succeeded in obtaining stipulation agreements on more than half the tracts in litigation. By the end of May, agreements of this type had been worked out on 416 tracts comprising 21,742 acres. In those cases where the negotiators failed to secure stipulation agreements, branch attorneys consented to submit them to a jury of view, an institution provided for under Tennessee law to assist litigants in reaching agreement on settlement prices for expropriated property. The jury, comprised of five persons named by the Federal District Court, visited each of the tracts in contention and then advised new settlement prices uniformly higher than those established by War Department appraisers. When the owners were unwilling to accept even these higher prices, the government stopped using this method of settlement.[8]

The rise of local opposition to the acquisition program seriously threatened to delay efforts by Department of Justice special attorneys to quickly bring the remaining unsettled cases to trial. Contributing to the opposition was the Federal District Court's late-1942 publication in its registry of the amounts placed on deposit for advanced payment to landowners, in compliance with the declaration-of-taking procedure. Because these amounts represented a percentage of the total valuation of the tracts, the landowners easily deduced the War Department's appraised valuation on the various tracts. The coincidence of a local political campaign provided candidates with an opportunity to promise, if elected, to secure higher prices than those established by government appraisers. Area newspapers publicized widely the appraised prices and the local politicians' comments and, in general, were hostile to the acquisition program and its methods.[9]

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[8] *Knoxville Journal*, 9 Jan 43; Remarks of Congressman John Jennings, Jr. (Tenn.), U.S. Congress, House, *Congressional Record*, 78th Cong., 1st Sess., 22 Apr 43, Vol. 89, Pt. 10, pp. A1197–99.

By the end of November, many landowners were thoroughly aroused. On the twenty-third, a delegation of property holders petitioned the project manager of the CEW Land Acquisition Section, protesting the low appraisal prices. That evening more than two hundred owners met; they formed a landholders investigation committee and made arrangements to hire lawyers and appraisers so that committee members could receive expert assistance. Taking note of these developments, a Knoxville newspaper commented that "the public of course actually knows nothing in detail of the justice of the protests being made by these citizens. . . . We do know that since everybody else is getting a fair price for the material and labor which will go into this Federal project, there is certainly no justification for these farmers being singled out for an economy slaughter."[10]

Dissatisfaction with appraised values was not the only cause for opposition. Relocation of more than one thousand landowners and tenants with their families proved difficult. Recent TVA acquisition of much of the good river bottom farmland in the vicinity had created a shortage of available vacant farms, enhanced local land values, and forced many farm people to move. Some of the displaced farmers who had moved to the Clinton site naturally resented having to move again. Even vacant houses in nearby towns were at a premium because of the influx of construction workers for the new project. Many landowners lacked sufficient ready cash to move on short notice. The War Department had no funds to aid them and adequate assistance was not immediately obtainable from other government agencies, such as the Farm Security Administration. Even owners with financial resources found that the District's deadlines on vacating did not give them sufficient time to hire moving vehicles, which were in short supply in the local area.[11]

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[9] MDH, Bk. 1, Vol. 10, pp. 2.9 and 2.42–2.43, DASA; *Knoxville Journal*, 1, 20, and 25 Nov 42; Fine and Remington, *Corps of Engineers: Construction*, pp. 174–84. Numerous examples of local opposition to War Department land acquisition are presented in the last-named source.

[10] *Knoxville Journal*, 24 Nov, 25 Nov (source of quotation), 30 Dec 42; Remarks of Jennings, *Congressional Record*, 78th Cong., 1st Sess., 22 Apr 43, Vol. 89, Pt. 10, pp. A1197–99.

[11] MDH, Bk. 1, Vol. 10, pp. 2.40–2.42, DASA; Telg, Jennings to Secy War, 24 Oct 42, copy in ibid., App. B2b, DASA; Robinson, *Oak Ridge Story*, pp. 26 and 28.

Rumors contributed considerably to fomenting local opposition. One persistent rumor was that the Clinton site was being acquired for the benefit of a large private corporation in flagrant abuse of the right of eminent domain. But overriding security requirements prevented District officials from providing the public with a general explanation. Thus, in an attempt to abate public criticism, Col. John J. O'Brien, chief of the CE (Corps of Engineers) Real Estate Branch, requested that the Department of Agriculture investigate the appraisal program. The department's factfinders later stated in their report that "the general management of the project, the appraisal of the land and the approach to the landowners have been fair and just, and we do not see what would be accomplished by a reappraisal of the land." The Engineers' resurvey of the area had revealed, they continued, that in many instances the tracts were actually smaller than recorded in existing property deeds; that the owners had tended to overvalue their land because they were prone to exaggerate its productivity; and, because many were veterans of one or more of the five previous TVA land acquisition projects within 70 miles of the Clinton site, that they had developed "a technique of complaining" that had proved to be very effective in securing higher prices for their property.[12]

Meanwhile, disaffected farmers sought the assistance of their congressman, John Jennings, Jr., a Republican from Knoxville. As early as October 1942, Jennings had written to Secretary Stimson on behalf of his constituents: "I realize the necessity of the step taken but I do hope adequate steps will be taken to safeguard these people, that they speedily be paid for their farms, and every step possible be taken to see that they are relocated on farms."[13] Although the War Department promptly had assured him "that every effort will be made to preserve the interests of the landowners concerned,"[14] the protests continued to increase. Feeling the futility of his earlier efforts, Jennings submitted a resolution to the House of Representatives on 1 February 1943, requesting creation of a select committee to investigate the prices offered landowners. "A large number of owners . . . ," the resolution read, "assert that the War Department has had the land appraised by nonresidents of the State of Tennessee who are totally unfamiliar with the value of such land. . . . Inexpert and unfair appraisals . . . are resulting in the forced sale of such land . . . at prices totally inadequate to enable the former owners to acquire homes and farms of comparable value."[15]

The House took no immediate action on Jennings' resolution, and he continued to seek relief for his constituents through War Department channels. In late February, he informed Under Secretary of War Patterson that he was receiving numerous complaints of destruction of buildings and other facilities on the site before providing owners the usual opportunity to salvage them. Patterson replied that such salvage was not feasible because it would take too long and interfere with construction activities already in progress. Furthermore, he assured Jennings, no waste was involved because Manhattan District engineers were converting existing buildings on the site for use by the project wherever this was possible. Again in April, Jennings complained to Corps of Engineers officials that improper statements concerning landowners were being made by their personnel in testimony before the jury of view. Corps observers who had attended the jury hearings said the congressman's allegations were not true. Finally, on 9 July, Chairman Andrew J. May of the House Military Affairs Committee, to which the resolution had been referred for review, appointed Representative Clifford C. Davis, a Democrat from the Tenth District of Tennessee, to carry out an inquiry. Davis selected Representatives Dewey Short, a Republican from Missouri, and John Sparkman, a Democrat from Alabama, as members of an investigating subcommittee and also invited Jennings to be present at the subcommittee's public hearings.[16]

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[12] Memo, George E. Farrell (Agri Dept specialist) to O'Brien, sub: Kingston Demolition Range, 19 Feb 43, copy in MDH, Bk. 1, Vol. 10, App. B2e, DASA.

[13] Ltr, Jennings to Secy War, 17 Oct 42, copy in ibid., App. B2a, DASA.

[14] Ltr (source of quotation), John W. Martyn (Admin Asst to Secy War) to Jennings, 27 Oct 42, App. B2a; Telgs, Jennings to Secy War, 24 Oct 42, and Und Secy War to Jennings, 3 Nov 42, App. B2b. Copies in ibid., DASA.

[15] Quotation from *H. Res. 91*, *Congressional Record*, 78th Cong., 1st Sess., 1 Feb 43, Vol. 89, Pt. 1, p. 508. See also Remarks of Jennings on *H. Res. 91*, ibid., 2 Feb 43, p. 509; *Knoxville Journal*, 4 Feb 43.

Announcement of the pending investigation came while the Justice Department special attorneys were pushing ahead with trial of condemnation cases on the Clinton tracts. The federal court juries, almost without exception, substantially increased payments to property holders. This seemed to further confirm the prevailing local view that the original appraisals were far too low and farmers who had accepted payment ought to be entitled to supplementary compensation. After consulting with Manhattan officials, the Justice Department decided to suspend further trials, at least temporarily, as the congressional investigation might result in a major revision of the appraisal data upon which the government was basing its prosecution of condemnation cases.[17]

The War Department determined to adhere to a policy of full cooperation with the congressional investigators. The ORD division engineer instructed the CEW project manager to take "extreme care . . . to prevent adverse reaction because of any claims being made that the War Department is pursuing a non-cooperative policy."[18] Manhattan officials did not interfere when a subcommittee investigator interviewed landowners who had written letters of complaint. The CEW project manager responded promptly to a written request from the House Military Affairs Committee general counsel for a comprehensive statement of its functions and activities, including a list of the appraisers who had worked on the project, together with a description of their qualifications; however, he did not release any records to the subcommittee without approval of the ORD division engineer.[19]

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[16] Ltrs, Jennings to Und Secy War, 27 Feb 43, Und Secy War to Jennings, 13 Apr 43, and Lt Col C. C. Fletcher (Act Real Estate Off for ORD Div Engr) to Reybold, sub: Ltr of Jennings Re Alleged Improper Statements of J. H. McKenzie (Just Dept Spec Atty), 15 Apr 43, copies in MDH, Bk. 1, Vol. 10, App. B2d–e, DASA. See also ibid., pp. 2.11–2.12, DASA; *Knoxville Journal*, 10–11 Jul and 13 Aug 43.

[17] 1st Ind, Fletcher to Morgan, 13 Jul 43, to Ltr, Morgan to ORD Div Engr, sub: Investigation of Appraisals by Congressional Investigating Committee, 12 Jul 43, copies in MDH, Bk. 1, Vol. 10, App. B2h, DASA.

[18] Ibid.

The subcommittee held two public hearings: on 11 August at Clinton, for the benefit of Roane County residents; and the following day at Kingston, for Anderson County residents. About three hundred persons, mostly land owners and their families, attended at Clinton, but considerably fewer were present in Kingston. The CE Real Estate Branch head sent his chief appraiser and an officer to represent the Engineers chief, General Reybold, at the hearing; the ORD division engineer, also his chief appraiser; and the district engineer, the CEW project manager.[20]

At Clinton, Congressman Jennings reviewed the history of the acquisition, emphasizing particularly the landowners' complaints that they had been underpaid for properties taken over by the government and, as a final comment, declaring that all of his own efforts to have the War Department reconsider appraisals had been turned down "as cold as ice." [21] In subsequent testimony, War Department officials, disgruntled landowners, and project appraisal staff members asserted that appraisers had greatly undervalued most properties, failed to interview owners, and used coercion in getting stipulations. Some witnesses charged that the CEW project manager had promised owners they would have an opportunity to salvage their buildings and equipment, but they were not permitted to do this. The ORD chief appraiser took the tack in his testimony that if the appraisers and negotiators had done all that was alleged by the landowners, they were acting contrary to all instructions issued by General Reybold. He urged that the appraisers and negotiators be given a hearing, but only two witnesses representing this group were called to testify, and they both vehemently denied most of the charges that had been made against them. The subcommittee adjourned on 12 August, after hearing testimony from Anderson County owners at Kingston.[22]

The congressional committee did not make its report public until December. The report consisted chiefly of ten recommendations for improving War Department real estate acquisition practices, only two of which related specifically to the CEW program. The first stated that the War Department should review and make adjustments in all those cases at the Clinton site where "the landowner was persuaded, against his better judgment, by coercion, threat, or promise, for whatever reason or reasons, to accept less than the true value of his property." The second recommended that "landowners who suffered losses on standing crops . . . for any reason not attributable to the landower, should be properly compensated for said losses." The rest of the recommendations, taken as a group, constituted a critique of War Department acquisition policies in general. More care should be taken to ensure protection of landowners' constitutional rights as guaranteed under the Fifth Amendment. In ascertaining fair prices on land, the government real estate appraisers should give more attention to determining comparable land values and take into consideration all factors relating to relocation of the owner on property similar to that he had given up. To make sure that these objectives were achieved, War Department real estate agencies should employ only fully qualified appraisers and negotiators. The Corps of Engineers' real estate manual should be revised to cover unusual conditions, such as those found at the Clinton site. Finally, no promises or commitments should be made to property holders, except where they could be made a matter of written official record.[23]

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[19] Ibid.; Ltrs, Colgan (for H. Ralph Burton, House Mil Affairs Committee general counsel) to Morgan, 3 Aug 43, and Morgan to Colgan, 6 Aug 43, copies in MDH, Bk. 1, Vol. 10, App. B2i, DASA.

[20] The town of Clinton was located 4 miles northwest of the site. Ltr, Col R. G. West (Ex Off, ORD) to Reybold, sub: Investigation of CEW Land Acquisition at Harriman, Tenn., 30 Aug 43, copy in MDH, Bk. 1, Vol. 10, App. B2m, DASA.

[21] Ibid.

[22] Ltrs, Morgan to Fletcher, subs: Rpt on Hearing Before House Mil Affairs Subcommittee in Connection With Land Acquisition at Harriman, Tenn., 11 Aug 43, and Rpt of House Mil Affairs Subcommittee—CEW, 13 Aug 43; Ltr, West to Reybold, sub: Investigation of CEW Land Acquisition at Harriman, 30 Aug 43. Copies of all in MDH, Bk. 1, Vol. 10, App. B2q and m, DASA. *Knoxville News-Sentinel*, 12–13 Aug 43. *Knoxville Journal*, 12–13 Aug 43.

Save for a brief delay in prosecuting the condemnation cases, the congressional investigation interfered very little with land acquisition progress and not at all with construction of the U-235 production facilities. Nothing came of the committee's rather severe criticism of appraisal prices, as neither Congress nor the War Department took steps to give additional compensation to landowners whose property had been acquired under stipulation agreements. By August 1944, all of the original 56,700-acre site had been acquired. As finally constituted, it consisted of 806 tracts secured by purchase, 38 tracts held under easements, and 4 tracts obtained under TVA temporary-use permits. In September, three months after closing down operations, the CEW Land Acquisition Section reopened its Harriman office to monitor the additional acquisition of approximately 2,800 acres. Needed to ensure greater security of the gaseous diffusion plant, this acquisition involved negotiations on 41 separate tracts and was not completed until March 1945.[24]

Total cost of the CEW real estate acquisition program cannot be determined, because project records list administrative charges as part of the overall expenditures for engineer military activities. The actual sum paid out for purchase of land and improvements, for severance damages, and for certain other nonadministrative costs totaled slightly more than $2.6 million, substantially less than the estimated cost of $3.5 million in the original directive of 29 September 1942. Of the total, the Army expended the largest part, $2.58 million, in outright acquisition of slightly more than 55,000 acres, purchased at an average cost of about $47 per acre.[25]

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[23] The recommendations were printed in the *Knoxville Journal* on 6 Dec 43. Comments defending War Department procedures as they related to each of the recommendations are given in MDH, Bk. 1, Vol. 10, pp. 2.12–2.16 and App. F5, DASA. See also U.S. Army CE Real Estate Manual, 1942.

[24] MDH, Bk. 1, Vol. 10 pp. 2.45–2.46 and App. E1–E4, DASA; Ltr, Robins (Dep Chief of Engrs) to CG ASF, sub: Acquisition of Additional Land for Scty Purposes in K-25 Area, 28 Aug 44, copy in ibid., App. B1f, DASA.

Los Alamos

Although the size of the Los Alamos site approached that of the Clinton site, its acquisition presented far fewer problems for the CE Real Estate Branch. Federal agencies already owned and controlled 90 percent of the land needed for the site, and for this the War Department had only to negotiate a comparatively simple transfer agreement with each agency. Furthermore, because a relatively small number of private owners held title to the remaining parcels, branch officials anticipated that negotiations with individual owners would be a far less time-consuming operation than at the Tennessee site.[26]

On 25 November 1942, Under Secretary of War Patterson approved a directive to acquire a site at Los Alamos "for establishment of a Demolition range." In support of his request for approval of this acquisition, the Engineers chief had submitted data derived from two comprehensive preliminary reports—one prepared by the division engineer of the Southwestern Division (SWD) at Dallas, Texas, and the other by that division's district engineer at Albuquerque, New Mexico. These reports indicated that the Manhattan Project required approximately 54,000 acres, most of it semiarid forest and grazing lands located on the east slopes of the Jemez Mountains in Sandoval County. Cost of acquisition, the reports estimated, would be small, because all but about 8,900 acres were federally owned and the grazing and forest lands were of relatively low value. The directive set the approximate cost at $440,000 and authorized the Engineers chief to finance the acquisition from available engineer funds.[27]

Because the process of acquiring the Los Alamos site promised to be relatively uncomplicated and speedy, there was little need for establishing a special real estate project office. The SWD Real Estate Branch in Albuquerque had sufficient staff and resources to oversee the myriad details and the district engineer had assigned one of his assistants, Maj. John H. Dudley, to coordinate and supervise all phases. Working closely with Lt. Col. John M. Harman, the Los Alamos post commander designate, the Albuquerque real estate staff took immediate steps to implement the plan to purchase

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[25] Ibid., p. 2.47, DASA; Ltr, W. T. Brooks (State of Tenn Hwy Engr) to ORD Div Engr, 8 Jul 43; Ltr, West to Brooks, 3 Sep 43; Ltr, J. W. Love (Harriman Power Dept Mgr) to Sen Tom Stewart (Tenn.), 10 Jan 44; Ltr, Robins to Sen Kenneth D. McKellar (Tenn.), 11 Feb 44; 1st Ind, O'Brien to ORD Div Engr, 25 Jul 44, to Ltr, Fletcher to Reybold, sub: Edgemoor Bridge and Solway Bridge, Tenn., 17 Jul 44. Copies of all in ibid., App B2f and n–o, DASA. Robinson, *Oak Ridge Story*, pp. 26 and 28. Some 3,720 of the total 58,900 acres brought under CEW control already were owned by the government or were acquired by lease, easement, or use permit.

[26] MDH, Bk. 8, Vol. 1, "General," pp. 3.5–3.6, DASA. Selection of the Los Alamos site is discussed in detail in Ch. IV.

[27] Quoted phrase from Ltr, Robins (for Chief of Engrs) to CG SOS, sub: Acquisition of Land for Demolition Range at Los Alamos, N.Mex., and 2d Ind (directive approval), Patterson to Chief of Engrs, both 25 Nov 42, Incls to Memo, O'Brien to Ashbridge, sub: Land Acquisition in Connection With MD, 17 Apr 43, MDR. See also Prelim Real Estate Rpt, SWD Div Engr, sub: Los Alamos Proj, 21 Nov 42, Admin Files, Gen Corresp, 319.1 (Rpts), MDR; Rpt, U.S. Engrs Office, Albuquerque Dist, sub: Proposed Site for Mil Proj at Los Alamos Ranch School, Otowi, N.Mex., 23 Nov 42, Admin Files, Gen Corresp, 600.03, MDR.

TYPICAL TERRAIN OF THE LOS ALAMOS SITE

the site in five separate sections (A, B, C, D, and E), which ensured compliance with the War Department's policy of taking possession of property only as it was actually needed.[28] *(See Map 5)*

Area A comprised a large block of land at the center of the site, which include the fifty-odd buildings and expansive campus grounds (several hundred acres) of the Los Alamos School that the Army acquired first and had full title to by early 1943 under terms of a $350,000 direct-purchase contract. The other areas—Area E to the north of Area A and Areas B, C, and D to the south—formed a kind of security belt to protect the central facilities planned for Area A, and also assured the Army control over the scarce existing water sources.[29] The largest tract in these areas comprised a part of the Santa Fe National Forest under jurisdiction of the Department of Agriculture's Forest Service. In response to Secretary Stimson's request, Agriculture Secretary Claude Wickard authorized the War Department "to occupy and use for so long as the military necessity continues . . ." an area of some 45,667 acres. Colonel Harman and the Forest Service's regional forester at Albuquerque worked out the details of the transfer, including administration or termination of any rights and privileges granted local residents and provision for management and fire protection

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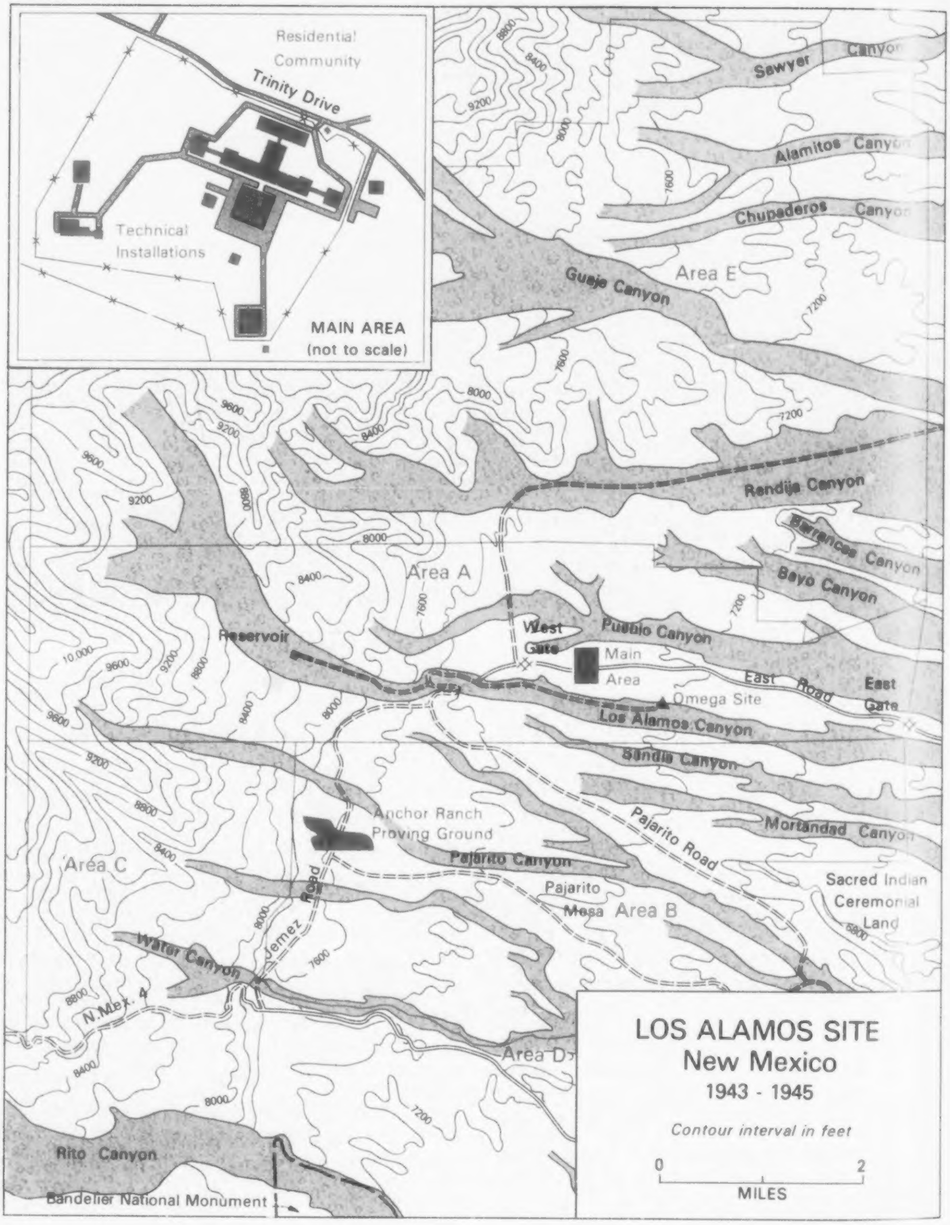
[28] MDH, Bk. 8, Vol. 1, pp. 7.11–7.12, DASA.

[29] Detailed data pertaining to the water supply problem at Los Alamos can be found in Admin Files, Gen Corresp, 671.1 (Water Supply), MDR.


Residential
Community
Trinity Drive
Technical
Installations
MAIN AREA
(not to scale)
Sawyer Canyon
Alamitos Canyon
Chupaderos Canyon
Area E
Guaje Canyon
Rendija Canyon
Barrancas Canyon
Bayo Canyon
Area A
Reservoir
West
Gate
Pueblo Canyon
Main
Area
East Road
East
Gate
Omega Site
Los Alamos Canyon
Sandia Canyon
Anchor Ranch
Proving Ground
Pajarito Road
Mortandad Canyon
Area C
Pajarito Canyon
Pajarito
Mesa
Area B
Sacred Indian
Ceremonial
Land
Jemez Road
Water Canyon
N.Mex. 4
Area D
Rito Canyon
Bandelier National Monument
10,000
9600
9200
8800
8400
8000
7600
7200
6800
LOS ALAMOS SITE
New Mexico
1943 - 1945
Contour interval in feet
0
2
MILES

MAP 5

of the forests. Subsequently, the SWD Real Estate Branch secured several additional small tracts of public land to meet the project's needs for a 25-mile power line right of way, bringing the total acquisition at Los Alamos during the war to 45,737 acres. Final cost of all property at Los Alamos purchased outright, leased, secured by easement, and otherwise acquired during the war was $414,971.[30]

Hanford Engineer Works

Although the District's real estate acquisition program in south central Washington started in February 1943, adjudication of land cases resulting from it ran on for many months after the war was over.[31] Legal complications, unfavorable publicity, administrative difficulties, the possibility of congressional inquiries, and the usual local opposition all threatened to frustrate the combined efforts of General Groves and the Hanford Area Engineers Office and CE Real Estate Branch staffs. Only by instituting the most vigorous countermeasures, both at the Hanford Engineer Works (HEW) and in Washington, D.C., were they able to prevent serious delays in Du Pont's construction activities and major violations of project security.

On 9 February, Under Secretary of War Patterson approved a letter directive (dated 8 February) authorizing acquisition of more than 400,000 acres at the Hanford site. (*See Map 4.*) Shortly thereafter, the PD (Pacific Division) Real Estate Branch established a local project office, designated the HEW Land Acquisition Office, in Prosser, county seat of Benton County. Branch attorneys immediately requested an order of possession from the U.S. District Court for the Eastern District of Washington State, Southern Division, and District Court Judge Lewis B. Schwellenbach on the twenty-third issued the order, opening the way for the project real estate office to begin collection of specific appraisal data and to gain right of entry to the site. Almost all of the land was being used for crops or grazing. More than 88 percent (about

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[30] Compton, *Atomic Quest*, p. 129; Groves, *Now It Can Be Told*, p. 67; Memo, Dudley to Groves, sub: Cooperative Arrangements With Other Govt Agencies, 13 Jan 43, Admin Files, Gen Corresp, 380.01, MDR; MDH, Bk. 8, Vol. 1, pp. 2.7, 3.3–3.6, 5.15–5.21, DASA; CE Constr Div, Map of Los Alamos Demolition Range, 6 Aug 43, copy in ibid., App. A3, DASA; Ltrs, Secy War to Secy Agri, 22 Mar 43, and Secy Agri to Secy War, 8 Apr 43 (source of quotation), and Memo of Understanding Between Harman and Frank C. W. Pooler (Region 3 forester, Albuquerque), 22 Mar 43, copies in ibid., Apps. D2–D8 and F, DASA. See Ch. XVIII on the acquisition of a right of way for a connection with the Bernalillo–Santa Fe line of the New Mexico Power Company and SWD map of power transmission line in ibid., App. 5, DASA.

[31] For detailed accounts of land acquisition at Hanford see MDH, Bk. 4, Vol. 4, DASA; Du Pont Constr Hist, Vol. 1, pp. 11–13, HOO; Groves, *Now It Can Be Told*, pp. 75–77; Ltr, Gavin Hadden (Constr Div, OCE) to O'Brien, sub: Hist of Land Acquisition, HEW, 30 Jul 45, and Incls, Admin Files, Gen Corresp, 601 (Hanford), MDR; Ltr, Robins (Act Chief of Engrs) to CG SOS, sub: Acquisition of Land for Gable Proj, Pasco, Wash., 8 Feb 43, and 2d Ind (directive approval), Patterson to Chief of Engrs, 9 Feb 43, Incls to Memo, O'Brien to Ashbridge, sub: Land Acquisition in Connection With MD, 17 Apr 43, MDR. The term *Gable*, mentioned in the above directive, referred to one of the most prominent topographical features of the Hanford site, Gable Mountain. On approval of the site by Du Pont and the Metallurgical Laboratory see Ltr, Roger Williams (TNX Div chief, Du Pont) to Lt Col Franklin T. Matthias (Hanford Area Engr), 2 Feb 43, Admin Files, Gen Corresp, 601.1 (Hanford), MDR, and Memo, Compton to Maj Arthur V. Peterson (Chicago Area Engr), sub: Safe Distance at Area 100, 1 Feb 43, Admin Files, Gen Corresp, 600.12 (Projs and Prgms), MDR.

378,000 acres) was sagebrush range land interspersed with volcanic outcroppings, where some eighteen thousand to twenty thousand sheep grazed during winter and spring. Some 11 percent (almost 49,000 acres) was farmland, much of it irrigable but not all under cultivation. Less than 1 percent (under 2,000 acres) consisted of town plots, rights of way, school sites, cemeteries, and similarly used land, most of it in or near the three small communities of Richland, Hanford, and White Bluffs.[32]

More than one-third of the Hanford area was government owned: federal government, nearly 71,000 acres; Washington State, over 45,000 acres; and five local counties (Benton, Yakima, Grant, Franklin, and Adams), about 41,000 acres. Railroad companies (chiefly the Chicago, Milwaukee, St. Paul and Pacific) owned almost 46,000 acres. More than 225,000 acres belonged to private individuals or to corporate organizations, including over 6,000 acres owned by several irrigation districts.

The overall plan called for division of the site into five areas. The PD Real Estate Branch chief designated areas A, B, C, D, and E in accordance with their anticipated use and in relation to how they would be acquired.[33] Area A, a tract averaging about 14 miles in diameter at the center of the site, would be the location of the main production facilities and would be purchased outright because, for safety and security, all persons not involved in plant operations would eventually have to be cleared from the area. Area B, a safety belt averaging 4 miles in width, surrounded Area A and would be leased, with any owners who remained on it subject to eviction on short notice. Area C, two narrowly connected parcels in the southeast corner of the site constituting a protective zone for Richland, the operating village, and for the nearby support installations for the plutonium production plants in Area D, would be leased or purchased as necessary. Most of Area D, lying immediately west of the Columbia River and adjacent to the village site, would be purchased. Finally Area E, two small appendages athwart the river at the northwest corner of the site and comprised principally of lands in an irrigation district, would be acquired only to the extent necessary for project security and operations.

In one very important respect the Hanford acquisition program differed from those at Clinton and Los

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[32] Statistics in this paragraph and the one that follows on the classification and utilization of land making up the Hanford site have been drawn from MDH, Bk. 4, Vol. 4, pp. 2.4–2.8, 3.1–3.3, Apps. A and C, DASA. The figures cited appear to be based upon a thorough analysis of the various sources relating to real estate acquisition, including Corps of Engineers maps, the real estate directives, and a summary of land acquisition issued in December 1946. Other sources consulted, most of them based on data collected while the acquisition program was in progress, reveal considerable discrepancy in the statistics given for ownership and utilization of the Hanford area in 1943 as compared with the data given in the MDH. See, for example, OCE, Basic Data on HEW, Pasco, Wash., 19 May 43, pp. 1–9, Admin Files, Gen Corresp, 601.1 (Hanford), MDR.

[33] Analysis of the plan based on Ltr, Robins to CG SOS, sub: Acquisition of Land for Gable Proj, Pasco, Wash., 8 Feb 43, Incl to Memo, O'Brien to Ashbridge, 17 Apr 43, MDR; Groves, *Now It Can Be Told*, pp. 75–76; MDH, Bk. 4, Vol. 4, p. 2.2 and App. A (maps), DASA; Memo, Norman G. Fuller (Act HEW Real Estate Proj Mgr) to Landowners in Hanford Engr Proj, 23 May 43, copy in ibid., App. C11, DASA; Du Pont Constr Hist, Vol. 1, pp. 11–12, HOO.

Alamos. Except for procurement of certain key tracts required for preliminary construction activities, the PD Real Estate Branch had considerably more time in which to acquire the site. In February 1943, research, design, and procurement activities for the plutonium production facilities barely had begun, and both the Army and Du Pont considered large-scale construction before summertime highly unlikely. This meant that clearing construction areas would not have to begin for a period of nearly six months. Project officials therefore decided to follow an acquisition procedure that they hoped might help limit the inevitable rise of local opposition. Branch attorneys delayed issuance of the usual declarations of taking, while HEW Land Acquisition Office negotiators endeavored to secure as many tracts as possible by direct purchase, the procedures for which had been made easier in January as a result of changes in the regulations authorizing higher initial payments to landowners. Both Justice Department attorneys assigned to the acquisition project and HEW officials were hopeful that the direct purchase procedure would result in more settlements out of court. They were also hopeful that, because direct purchase would allow farmers more time to harvest mature crops, it would counter the public criticism bound to arise from the apparent adverse effects of acquisition on the current national program for production of more "food for victory".[34]

By early March, the HEW Land Acquisition Office was ready to commence with site acquisition. In cooperation with the PD Real Estate Branch and the Hanford area engineer, Lt. Col. Franklin T. Matthias, the office hired a large staff of appraisers and negotiators from nearby states, many previously employed by the Federal Land Bank at Spokane, and in April opened a branch office at Richland to ensure closer liaison with the area engineer's staff and Du Pont officials. Matthias kept a careful eye on the office's activities, keeping in close touch through the PD Real Estate Branch liaison officer in his headquarters. He worked zealously for more efficient management of the acquisition process, adherence to proper procedures in transfer of land to the area office before occupancy by Du Pont personnel, and just treatment for the landowners. Whenever practicable, he approved the requests from those individual farmers who had to vacate but who wanted to remain on their farms past the imposed deadlines so that they could harvest the matured crops.

The HEW Land Acquisition Office acquired the first tract on 10 March 1943. During the spring and summer, acquisition and vacating of specified areas progressed reasonably well, although in early July the area engineer had to arrange for court eviction of seven holdout landowners whose continued presence in Area A threatened project security and obstructed land needed immediately by Du Pont. In early August, General Groves, Colonel Matthias, and CE Real Estate Branch officials met with representatives of the Justice Department and, seeking to avoid prolonged litigations, agreed upon certain changes in acquisition plans, including a revision in procedures for procuring lands held by irrigation districts.[35]

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[34] MDH, Bk. 4, Vol. 4, pp. 4.2 and 5.1, DASA; Groves, *Now It Can Be Told*, pp. 76-77; Matthias iary, 12 Mar 43, OROO.

But the early progress was deceptive, and the holdout and irrigation district litigation problems were straws in the wind of rising opposition. After two of the irrigation districts had initiated legal steps to secure compensation for their bonded indebtedness, they became rallying points for other dissatisfied elements. United in a common cause, the protesters joined together to complain that the government's real estate valuations were much too low and its advance allowances to owners inadequate.[36]

The crucial point of disagreement between the Hanford farmers and project appraisers was the question of how much compensation the landowners should receive for the crops (cherries, apples, pears, peaches, and other kinds of fruits, as well as asparagus, mint, and alfalfa) on their land at the time of acquisition. Many owners contended that if they were not to be permitted to stay on their land until crops could be harvested, they should be compensated for them, as well as for the land itself. Because the growing season for 1943 proved to be one of the most bountiful on record, the farmers' claims were greatly strengthened. By late spring, no longer able to ignore the crop question, the PD Real Estate Branch agreed to a proposal made by Justice Department attorneys that all tracts not yet acquired be reappraised to include crop values at the date of their taking.[37]

Project security and construction requirements made necessary the clearing of many of the farms before their crops could be harvested. Furthermore, on all the farms eventually taken over by the project, the Hanford area engineer had to provide for continued maintenance of the orchards and the preservation of the irrigation systems. For this purpose Matthias was able to work out arrangements for bringing prisoners from the McNeil Island Penitentiary, a federal institution located near Tacoma, to serve as a semipermanent agricultural work force. While this saved many crops, it did not fully placate the landowners' frustration, primarily because the government agency supervising the prisoners, the Federal Prison Industries, had no means to pay the owners the additional compensation many hoped to receive as a result of the exceptional abundance of the harvest.[38]

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[35] Memos, Matthias to Groves, sub: Crop Control and Disposal, HEW, 21 Aug 43, and O'Brien to Groves, sub: Revision of Boundaries of Area A, 3 Aug 43, Admin Files, Gen Corresp, 601.1 (Hanford), MDR; Matthias Diary, 5 Jul and 7 Aug 43, OROO.

[36] Memo, Hadden to Groves, sub: Rpt on Trip to HEW (21 Nov–4 Dec 44), 4 Dec 44, Admin Files, Gen Corresp, 601.1 (Hanford), MDR. This memo, with its accompanying inclosures, constituted a detailed report on the history and status of the program. MDH, Bk. 4, Vol. 4, pp. 4.1–4.2, DASA. Resolution of John Lindblad Post No. 71, American Legion, White Bluffs, Wash., 21 Apr 43, Admin Files, Gen Corresp, 601.1 (Hanford), MDR. Copies of this resolution, which was typical of the form that protests against the acquisition took, were sent to all members of the Washington State delegation in Congress and to the national headquarters of the American Legion.

[37] Groves, *Now It Can Be Told*, pp. 76–77; MDH, Bk. 4, Vol. 4, pp. 4.20–4.21, DASA.

[38] Groves, *Now It Can Be Told*, pp. 76–77; MDH, Bk. 4, Vol. 4, pp. 4.2, 4.13, and 4.20–4.21, DASA;

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Adding to the discontent were rumors that the War Department was using the right of eminent domain for the special benefit of Du Pont and was circulating information that cast doubt on the value of farmlands in the area. News of controversy over the Hanford acquisition program reached Washington just at the time the administration was greatly concerned about the likelihood of severe food shortages in the country. In response to an inquiry from the President, the War Department replied that the Army was doing everything possible to protect agricultural interests at Hanford and anticipated salvaging more than three quarters of the crops.[39]

The Military Policy Committee, meeting on 30 March, discussed the President's concern over the possible adverse effects of the Hanford acquisition on the administration's food production campaign and decided to address the issue. Acting on behalf of the committee, OSRD Director Vannevar Bush shortly thereafter communicated with Roosevelt "as to the need for so much land, the need for taking the town site in Richland and the effect on agriculture." [40] Bush did not succeed in ending the President's disquietude, and when the matter came up again at a Cabinet meeting on 17 June, Roosevelt raised the question as to whether the leaders of the atomic bomb project might not consider moving the plutonium production installation to another site. The President's query was just that, and not a directive. Political considerations may have been the pressing motivation. At the time, the Truman Committee,[41] alerted by letters from Hanford area residents, was making inquiries to the War Department concerning the government's acquisition of so much agricultural land, and congressmen from Washington State were channeling the complaints they had received on the matter to both the War and Justice Departments. Faced with having to answer to the President, Stimson looked to the Manhattan commander for an explanation of the Hanford situation. Late in the afternoon of the seventeenth, General Groves explained to the Secretary that representatives of Du Pont and Manhattan, including himself, had weighed most carefully the factors favoring selection of Hanford and concluded that it was the only place in the United States "where the

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Matthias Diary, 30 Mar, 10 Jun, 7 Jul, 17 and 22 Aug, 3 Sep 43, OROO; Memo, Matthias to Groves, sub: Crop Control and Disposal, HEW, 21 Aug 43, MDR; Du Pont Constr Hist, Vol. 4, pp. 1348–49, HOO.

[39] Memo, Matthias to Groves, sub: Public Mtg in Which Du Pont Participated, 23 Apr 43, Admin Files, Gen Corresp, 600.1 (Constr-Hanford), MDR; MDH, Bk. 4, Vol. 4, pp. 4.23–4.24, DASA; Matthias Diary, 16 Mar and 27–28 Apr 43, OROO; Memo, Reybold to Maj Gen Edwin M. Watson (Mil Aide to Roosevelt), sub: Gable Proj, and Incl (draft of letter for President's reply to letter from A. S. Goss, chairman of The National Grange), 8 Apr 43, Admin Files, Gen Corresp, 601.1 (Hanford), MDR; Groves Ms, pp. 175–76, CMH; Bureau of the Budget, *The United States at War: Development and Administration of the War Program of the Federal Government* (Washington, D.C.: Committee of Records of War Administration No. 1, War Records Section, Bureau of the Budget, 1946), pp. 324–26 and 365.

[40] MPC Min, 30 Mar 43, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR.

[41] The Truman Committee was a special committee of the U.S. Senate, formed in 1943 at the instigation of Democratic Senator Harry S. Truman of Missouri to investigate the conduct of the national defense program. The committee continued its hearings until June 1948 under the successive chairmanship of Senators Truman, James M. Mead, and Owen Brewster.

work could be done so well." Reassured, Stimson called the President and "satisfied his anxiety." [42]

Stimson's assurance to the President by no means ended the threat of interference in the project by other interested agencies, especially Congress and the Department of Justice. When Representative Hal Holmes, the Republican congressman in whose district the site was located, had requested information from the War Department about the project, Groves directed Colonel Matthias to supply the congressman with data sufficient to answer questions from his constituents. After conferring with Matthias, Holmes agreed to cooperate fully with the acquisition program, although he emphasized that he did not wish the impression to be given to local landowners that he favored location of the project at Hanford. While he frequently interceded thereafter with Matthias and the War Department on behalf of his constituents in the Hanford area, Holmes abided by his pledge of cooperation with Manhattan. [43]

Washington's junior senator, Mon C. Wallgren, a Democrat, proved to be more of a problem. In April 1943, he forwarded to the Department of Justice correspondence that he had received from an attorney representing a group of dissatisfied Hanford landowners. This correspondence, as Wallgren undoubtedly knew it would, came to the attention of Norman M. Littell, assistant attorney general in charge of the Lands Division, the section of the Justice Department responsible for prosecution of all court cases arising from War Department condemnation procedures in land acquisition projects. Littell, who had practiced law in Seattle before his appointment to the Justice Department in 1940, was currently interested in promoting enactment of a bill he had drafted "that would provide for speedy and summary notice in proceedings to condemn property for war purposes, and to accelerate distribution of deposits and awards to persons entitled thereto in such cases. . . ." [44]

Littell used the opportunity to promote support among members of the Washington State congressional delegation for his bill, which Harry F. Byrd of Virginia had introduced into the Senate on 7 April. On the twenty-sixth, he sent a long letter to all members of the delegation, giving extensive details about the Hanford acquisition and expressing skepticism that the War Department could keep the project secret in view of the public character of condemnation proceedings. Littell also enclosed a copy of his bill, outlining reasons why it should be enacted. The Military Policy Committee considered the security aspects of Littell's letter but acceded to a request from General Styer, who undoubtedly was expressing Groves's wishes, "that in view of the general situation no action be taken on the matter." [45]

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[42] Stimson Diary (source of quotation), 17 Jun 43, HLS; Groves Diary, 17 Jun 43, LRG; Ltr, Hugh Fulton (Truman Committee chief counsel) to Julius M. Amberg (Spec Asst to Secy War), 15 Jun 43, in Senate Committee Investigating Natl Def Prgm, Ord Plants Recs, Ord Establishment, Hanford Ord Plants, USS.

[43] Matthias Diary, 5 and 8–9 Mar, 21 Apr, 3–4 Aug 43, OROO.

[44] Quotation from title of *S. 975*, *Congressional Record*, 78th Cong., 1st Sess., 7 Apr 43, Vol 89, Pt. 3, p. 3029. For details on Littell's pre-1940 activities see the biographical sketch in *Who's Who in America*, 1946–47, Vol. 24, pp. 1416–17, and Memo, MD Intel and Scty Div to OIC, sub: Littell's Request for Delay in Setting Hanford Condemnation Cases To Permit Reappraisal, 10 Nov 44, Admin Files, Gen Corresp, 601.1 (Hanford), MDR. This memo was, in fact, the intelligence report Lansdale submitted to Groves.

A short time later the Truman Committee, of which Wallgren was a member, exhibited an interest in the Hanford acquisition, which Littell well may have encouraged. In early June, the committee sent inquiries to the president of Du Pont and to Julius M. Amberg, special assistant to the Secretary of War. Amberg was asked to supply the committee with data on "the factors governing the choice of this location, the estimated cost of the project, the status of construction at present, and [with] suitable comment with respect to the need for such an extensive tract of farm land." [46] Responding to these inquiries, General Groves, Harvey Bundy, Stimson's assistant, and Brig. Gen. Wilton B. Persons, the War Department's congressional liaison officer, reached agreement that the Secretary of War should request Senator Truman to eliminate Hanford from his investigation for reasons of military security. Truman heard from Stimson on the seventeenth and, with the understanding that the Secretary would assume full responsibility for project activities, agreed to stop further investigation.[47]

In preparation for the condemnation trials scheduled for early fall, Colonel Matthias arranged a meeting with Judge Schwellenbach and Justice Department officials on 27 August in Spokane. Participants included, besides the area engineer and Schwellenbach, representatives of the CE Real Estate Branch and Department of Justice lawyers assigned to prosecute the cases. The group discussed a number of problems, including the possibility of arranging for partial payments to landowners and giving the Justice Department attorneys more authority to increase appraised values in pretrial conferences. Apparently no firm agreement was reached on either of these matters, but Matthias found the meeting with Judge Schwellenbach worthwhile, "as it cleared up a number of misunderstandings concerning the Judge's philosophy and the decisions which he had been making in connection with the project." Following the meeting, the HEW Land Acquisition Office also sought permission from authorities in Washington, D.C., to increase allowances for a large number of tracts still in litigation.[48]

In October, the first condemnation trial by jury began at Yakima, and additional cases followed at regular intervals through the winter season, until early March 1944. Complying with the regular court procedure in Washington State, the selected jury for each case visited the Hanford site to inspect the particular tract(s) under adjudication before the trial proceeding. The trial results indicate that the juries found the landowners' claims to be just and that they consistently awarded payments greatly in excess of project appraisals. An official observer for the project attributed the higher payments to a general rise in land values in the months since the appraisals had been made, to the prevailing local prejudice against Federal Land Bank appraisers, and to the widely held belief that the project had no connection with the war emergency.[49]

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[45] Ltrs, Littell to Wallgren and to Holmes, both 26 Apr 43, Admin Files, Gen Corresp, 601.1 (Hanford), MDR; MPC Min (source of quotation), 5 May 43, MDR.

[46] Ltr, Fulton to Amberg, 15 Jun 43, USS.

[47] Ltr, Rudolph Halley (Fulton's Ex Asst) to Walter S. Carpenter, Jr. (Du Pont president), 8 Jun 43; Outline of [Proposed] Telecon with Sen Truman, 11 Jun 43; Memo, Bundy to Secy War, 11 Jun 43, and attached note bearing initials ECH (Miss Neary), 17 Jun 43. All in HB Files, Fldr 62, MDR. See also Ltrs, Carpenter to Halley, 14 Jun 43, and Amberg to Halley, 24 Jun 43, USS; Groves Diary, 11 Jun 43, LRG; Stimson Diary, 17 Jun 43, HLS.

[48] Matthias Diary, 27 (source of quotation) and 31 Aug 43, OROO.

While the Army opposed excessive payments to the owners, of greater concern was the slow progress of land acquisition during the trials. Settlements on more than 1,200 tracts averaged no more than seven cases per month. If this slow pace continued, Groves feared the essential secrecy of the project would be jeopardized, because of jury inspections in areas where construction was beginning and the inevitable public attention focused on the trials. As a way of speeding up the process, he arranged with the Justice Department for the assignment of more judges and requested an end to jury inspections.[50]

On 24 April 1944, General Groves, Colonel Matthias, and CE Real Estate Branch officials conferred with Assistant Attorney General Littell in a meeting at Yakima, arranged by Army Service Forces commander, Lt. Gen. Brehon B. Somervell, at Groves's instigation. They agreed that the Justice Department special attorney and the HEW Land Acquisition Office manager together could make adjustments in the appraised value of tracts to facilitate settlement of cases out of court. They also detailed the special attorney and the manager to work out means for closer coordination between the project real estate office and Justice Department officials in Yakima. Finally, Littell assented to establishment of a second court and additional judges.[51]

Under Secretary of War Patterson made the formal request for additional judges to Attorney General Francis Biddle, who agreed to the plan as worked out by Littell and Groves. Patterson pointed out to Biddle that soon, because of security requirements, the Army could no longer permit jury inspections of tracts. In late May, Littell informed Patterson that he had arranged for extra judges and, provided the Under Secretary could expedite the securing of parts needed for the Yakima courtroom air conditioning system, that the trials would continue through June and July.[52]

In spite of these efforts to speed up the acquisition process, the results were disappointing. Toward the end of the summer Littell seems to have decided that faulty War Department appraisal work was at the root of the acquisition difficulties at Hanford. Consequently, he directed an experienced appraiser on his own staff to make a sample reappraisal of some of the more than 700 tracts remaining unsettled. According to Littell, the appraiser found many cases of "inadequate and faulty appraisal work." [53]

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[49] Memo, Matthias to OCE (Attn: Groves), sub: Real Estate Appraisals, 18 Oct 43; Rpt, sub: Results of Trials—HEW (no date and, although no signature, appears to have been prepared by the HEW Land Acquisition Office at Prosser for the Office of the Division Engineer, Seattle, Wash.). Both in Admin Files, Gen Corresp, 601.1 (Hanford), MDR. Matthias Diary, 1 Nov 43, OROO.

[50] Memo, Groves to Reybold and to CG ASF, sub: HEW, 23 Mar 44, Admin Files, Gen Corresp, 601.1 (Hanford), MDR.

[51] Ibid. Colonel O'Brien, chief of the CE Real Estate Branch, refers to the memorandums of understanding in a letter to Littell, 13 May 44, same files. Matthias Diary, 24 Apr 44, OROO.

[52] Ltrs, Und Secy War to Biddle, 2 May 44, and Biddle to Und Secy War, 10 May 44, Admin Files, Gen Corresp, 601.1 (Hanford), MDR; Telg, Littell to Und Secy War, 24 May 44, HB Files, Fldr 80, MDR; MDH, Bk. 4, Vol. 4, p. 4.4, DASA.

After a conference with Patterson on 1 September, Littell took another step, apparently on his own initiative, to expedite the condemnation trials. He appointed C. U. Landrum as a special assistant to the U.S. attorney to conduct those cases coming up for trial in September. Littell described Landrum as "one of the outstanding trial lawyers of the country . . . ," but, at the same time, emphasized that Landrum's assignment was not to be interpreted as an indication that the previously assigned special attorney had not done a good job in the earlier cases. Verdicts in the September trials, however, were even less satisfactory than those handed down in the preceding cases. Juries awarded payments to landowners that constituted an even greater percentage of increase over original government appraisals than those previously granted. In some instances, the payments were higher than the largest amounts demanded by attorneys for the owners.[54]

At this juncture, Littell wrote directly to Patterson, outlining the unfavorable trend in the recent trials. "It has been clear for some time that either the appraisals of the War Department were too low or the jury verdicts on the trial of condemnation cases were too high. . . . I am having a further and more extensive recheck [made] of valuations in this project and will be guided by the outcome of this work in the disposal of future cases in the Hanford Project." In reply, General Groves and CE Real Estate Branch officials prepared a defense of the Army's role in the acquisition at Hanford for the attention of Attorney General Biddle; however, before it was dispatched, Littell took direct action.[55]

On 13 October, in Washington to participate in the Democratic campaign for the 1944 presidential election, Littell suddenly appeared before the district court in Yakima and made a request to Judge Schwellenbach that no more condemnation cases be brought to trial until the Justice Department had an opportunity to reappraise all tracts upon which suits were pending. Although Groves had been alerted to the fact that Littell was making a trip to the Hanford area, his appearance before the court came as a complete surprise to project officials and Schwellenbach, none of whom had been notified of his intentions. Littell reviewed the history of the land acquisition at Hanford, criticizing the War Department for the piecemeal fashion in which it had taken possession of many of the tracts. This practice, he asserted, caused confusion and resentment among the owners so that an unusually large proportion of the cases had to be brought to trial for settlement. He reiterated that the major cause of difficulty was the inadequate appraisal work by the Corps of Engineers, a fact uncovered by his own appraisal expert during an investigation. He promised Judge Schwellenbach that he would expedite reappraisals and settlements at once, optimistically predicting that a majority of cases would be ready for final settlement within a month. Schwellenbach stated that he had not anticipated Littell's motion but would take it under advisement.[56]

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[53] Ltr (source of quotation), Littell to Und Secy War, 28 Sep 44; Draft Memo, Groves to Und Secy War, sub: HEW, 13 Oct 44. Both in Admin Files, Gen Corresp, 601.1 (Hanford), MDR; MDH , Bk. 4, Vol. 4, pp. 4.14, 5.2, App. B1, DASA; Matthias Diary, 24 Nov 44, OROO.

[54] Ltr (source of quotation), Littell to Und Secy War, 28 Sep 44, MDR; MDH, Bk. 4, Vol. 4, pp. 4.4–4.5, DASA.

[55] Ltr (source of quotation), Littell to Und Secy War, 28 Sep 44, MDR; Draft Memo, Groves to Und Secy War, sub: HEW, 13 Oct 44, and attached Draft Ltr, Und Secy War to Atty Gen, MDR (memo and letter never dispatched); Groves Diary, 11–13 Oct 44, LRG.

Littell's remarks before the district court received wide publicity in area newspapers, which played up the obvious political overtones of his statement. The local press also published a considerable number of editorials and letters from readers, as well as additional reports on the condemnation cases, during the latter part of October and early November, and a major news service picked up at least one story.[57]

Groves, who was not informed of Littell's court appearance until 16 October, saw the action as "obviously incompatible with essential military security, the need for which had been carefully explained to him [Littell]. His statement to the court has resulted in a considerable amount of undesirable publicity concerning a project which the President has personally directed should be blanketed with the utmost secrecy." A further unfortunate aspect of the incident, Groves noted, was that it gave the public the false impression that the War and Justice Departments were at odds on land acquisition policies, when, in reality, any differences that arose could be quickly settled by conference, as had been done at Yakima for the Hanford project in April 1944.[58]

Groves, now determined to take decisive action, worked closely with CE Real Estate Branch officials and Julius Amberg in preparing a new statement of the War Department's position, which Under Secretary of War Patterson sent to Attorney General Biddle on 7 November. This statement emphasized Littell's utter disregard of essential security and the one-sided character of much of his criticism of appraisal policies. It pointed out further that the War Department consistently had tried to cooperate with the Department of Justice and therefore could see no justification for Littell's "public airing of alleged differences between the Departments in contravention of expressed executive policy." At the same time, Groves launched a thoroughgoing investigation of the Littell incident and its aftermath of publicity. He sent his staff security officer, Lt. Col. John Lansdale, Jr., to the Hanford area to survey the situation. Lansdale submitted a comprehensive intelligence report to Groves on 10 November and took measures to curb newspaper publicity, particularly by Justice Department special attorneys.[59]

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[56] Memo, MD Intel and Scty Div to OIC, sub: Littell's Request for Delay in Setting Hanford Condemnation Cases To Permit Reappraisal, 10 Nov 44, MDR. Newspaper stories reporting Littell's statement to the court were published in two Spokane dailies on 14 Oct 44: the *Spokesman-Review* and the *Daily Chronicle*. Copies in Admin Files, Gen Corresp, 601.1 (Hanford), MDR. See also MDH, Bk. 4, Vol. 4, pp. 4.14–4.15, DASA; Matthias Diary, 14 Oct 44, OROO; Groves Diary, 11 Oct 44, LRG.

[57] Memo, MD Intel and Scty Div to OIC, sub: Littell's Request for Delay in Setting Hanford Condemnation Cases To Permit Reappraisal, 10 Nov 44, MDR; Msgs, Matthias to Dist Engr, Attn: Lt Col William B. Parsons (Intel and Scty Div chief), 20 and 24 Oct 44; Msgs, Matthias to Wash Liaison Office and Dist Engr, Attn: Lansdale and Parsons, 1–3 Nov 44; Memo, Maj Claude C. Pierce, Jr (Wash Liaison Office) to Groves, sub: Editorial in *Spoksman's* [*sic*] *Review*, 2 Nov 44. All in Admin Files, Gen Corresp, 601.1 (Hanford), MDR. This file also contains copies of many of the stories appearing in the local press.

[58] Ltr (source of quotation), Und Secy War to Atty Gen (prepared for Patterson's signature by Groves and the CE Real Estate Br), 7 Nov 44, Admin Files, Gen Corresp, 601.1 (Hanford), MDR; Groves Diary, 16 Oct 44, LRG.

On 21 November, Groves dispatched a special three-man investigation team to Hanford. Heading the team was Gavin Hadden, a long-time civil employee in the Engineers' Construction Division whom Groves had used on previous occasions as a troubleshooter. The team's instructions were to secure "a firsthand knowledge of conditions which influenced the problems of acquisition of Real Estate at . . . [the Hanford site] from February 1943 to date." [60] Yet before Hadden could submit a preliminary report, developments in the Justice Department contributed substantially to resolving the acquisition problems at Hanford. A feud of long-standing between Biddle and Littell over administration of the Lands Division had culminated on the eighteenth with the Attorney General's formal request that Littell resign. Instead of resigning promptly, however, Littell procrastinated and took advantage of his delay to submit to the Mead (formerly Truman) Committee a list of grievances against Biddle, expressly charging maladministration of certain land cases. Finally, when Littell ignored a second request for his resignation on the twenty-second, the Attorney General solicited the direct assistance of President Roosevelt to remove Littell from office, which occurred on the twenty-sixth. At the same time, Biddle dissuaded the Mead Committee from taking further interest in the controversy. Littell thus was prevented from making political capital out of his charge that he had been dismissed for testifying before the Senate committee, and further congressional inquiries into War Department land policies, which undoubtedly would have exposed the

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[59] Ltr (source of quotation), Und Secy War to Atty Gen, 7 Nov 44, and covering Memo, Groves to Und Secy War, 2 Nov 44. Both in Admin Files, Gen Corresp, 601.1 (Hanford), MDR. Copies of the letter are also in HB Files, Fldrs 51 and 80, MDR. Memo, Patterson to Roosevelt, 9 Dec 44, HB Files, Fldr 51, MDR, indicates that a copy of the 7 Nov 44 letter was sent to the President on that date. Memo, Amberg to Und Secy War, sub: Condemnation Proceedings With Respect to HEW Land, 7 Oct 44, HB Files, Fldr 51, MDR. Groves Diary, 16, 19, 23 Oct and 3, 4, 6 Nov 44, LRG. Msg, Matthias to Wash Liaison Office and Dist Engr, 1 Nov 44; Background Paper (no title or signature, but probably written in Groves's office as preparation for the 7 Nov 44 letter to Atty Gen Biddle), 3 Nov 44; Memo, MD Intel and Scty Div, Littell's Request for Delay in Setting Hanford Condemnation Cases To Permit Reappraisal, 10 Nov 44. All in Admin Files, Gen Corresp, 601.1 (Hanford), MDR.

[60] Memo, Hadden to Groves, sub: Rpt on Trip to HEW, 4 Dec 44, MDR.

Hanford project to widespread publicity, were avoided.[61]

With the departure of Littell there was a rapid return to normal relations between the War Department and Department of Justice in the land acquisition program at Hanford. The security problem posed by the legal right of juries to inspect properties in litigation was resolved in negotiations between Judge Schwellenbach and Colonel Matthias in March 1945. Henceforth, juries would be denied the right to inspect tracts subject to acquisition, because visits to the project site would be personally hazardous.[62]

By spring of 1945, settlement of those cases where outright purchase of land was necessary again attained an average rate of more than one hundred each month and continued at this pace until the end of the war in Europe in May brought a general slowing down of all acquisition activities. The land acquisition program at Hanford remained uncompleted at the end of December 1946, when the Army transferred control of the Manhattan Project to the newly created civilian agency, the United States Atomic Energy Commission. Total cost of real estate secured at Hanford by direct purchase and condemnation procedures up to that time had amounted to more than $5 million.[63]

Other Sites

Land acquisition was not a major activity at the many other sites occupied by Manhattan Project facilities. In most cases where acquisition was necessary, the Army usually was not as directly involved as at the Clinton, Hanford, and Los Alamos sites, although on occasion the local area engineer or the CE Real Estate Branch provided key assistance to project contractors seeking more land for their operations. Generally speaking, the major research and development programs located at universities employed existing facilities and expanded them on land already available on the campus or in nearby areas. This was true of most of the University of Chicago facilities for the Metallurgical Laboratory, although, for reasons of safety and security, the Army assisted the university in acquiring use of a small site in the forest preserve southwest of the city for the Argonne Laboratory. The University of California, operating under an OSRD contract, had acquired an 8.3-acre tract 2 miles north of the Berkeley campus as the site of most Radiation Laboratory activities. Other research centers, such as the SAM Laboratories at Columbia University and the Ames project at Iowa State College, used existing facilities and leased needed additional space adjacent to their campuses. For the three heavy water plants built in the United States at the Morgantown, Wabash River, and Alabama Ordnance Works, the Army's Ordnance Department made available land already previously acquired for munitions facilities. In the case of the Trail heavy water plant in Canada, the War Department leased an area of less than an acre from the operating contractor. Similarly, at the many other places where the atomic bomb program sponsored activities of some type, the project or its contractors acquired use of whatever land and facilities were necessary to their operations.[64]

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[61] The main developments in the Littell-Biddle controversy may be traced in the following documents: Memo, Littell to Charles Fahy (Act Atty Gen), 21 Aug 44; Ltr, Fahy (U.S. Solicitor Gen) to Mead, 1 Jan 45; Ltr, Littell to Rudolph Halley (Mead Committee chief counsel), 21 Nov 44 (which contains Littell's statement to the Yakima District Court concerning Hanford land cases); Memo, Littell to Mead Committee, sub: Issues Between Biddle and Littell . . . , 27 Nov 44; Ltr, Biddle to Mead, 27 Nov 44; Ltr, Littell to Mead, 30 Nov 44; Press Release, Mead Committee, 29 Nov 44; Atty Gen's Statement to Senate Committee on Immigration, 9 Dec 44 (in which Biddle further defended his dismissal of Littell); Memo, Sen Harley M. Kilgore (Mead Committee member), 4 Dec 44; Ltr, Littell to Mead Committee, sub: Answering Biddle's 9 Dec 44 Statement Re Reasons for Requesting Writer's Resignation as Asst Atty Gen, 8 Jan 45; Mead's Statement to U.S. Senate, 6 Dec 44. All in Senate Committee Investigating the Natl Def Prgm, Minor Investigations, Subject File, Norman Littell Controversy, USS. See also *New York Times*, 30 Nov 44; *Spokesman-Review*, 1 Dec 44; Groves Diary, 23 Nov 44, LRG.

[62] Matthias Diary, 16 Mar 45, OROO.

[63] MDH, Bk. 4, Vol. 4, pp. 5.2–5.4, 6.1–6.4, 7.1–7.2, Apps. B1–B2, DASA. Cost figures are based on Military Acquisition Reports, CR Form 5 and ENG Form 1010, 28 Feb 43 to 15 Dec 46, and on Land Acquisition Summary as of 31 Dec 46, cited in ibid., Apps. E10–E11, DASA.

For the more than 500,000 acres of land that the Manhattan Project purchased, leased, rented, or otherwise acquired during World War II, it paid out a sum of about $7.5 million. There were no major instances where failure to acquire land seriously delayed progress of the bomb project, primarily because of the vigorous and alert administrative actions on the part of General Groves and a great many Manhattan District and Corps of Engineers real estate staff members and, when needed, the strong support from Secretary Stimson and other key War Department officials. Their coordinated and effective efforts directly contributed to the Army's achievement of the essential goal of its land program: rapid acquisition of needed areas without compromising project security.

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[64] MDH, Bk. 1, Vol. 4, "Auxiliary Activities," pp. 11.3-11.5; Bk. 2, Vol. 2, "Research," pp. 2.1-2.5 and 11.1-11.2; Bk. 3, "The P-9 Project," pp. 3.3, 3.11, 3.13, 3.15; Bk. 4, Vol. 1, "General Features," p. 2.4 and App. B3; Bk. 4, Vol. 2, "Research," pp. 2.6 and 2.8; Bk. 5, Vol. 2 "Research," pp. 2.7-2.8, DASA. See Ch. V (Argonne Lab and heavy water plants); Ch. VI (Rad Lab); Ch. VII (SAM Labs); and Ch. IX (Met Lab).

CHAPTER XVI

Manpower Procurement

The Manhattan Project in its manpower requirements and problems, as in so many other respects, was unique among wartime programs. Its work force, for example, was notable for its great diversity, running the gamut from completely unskilled manual laborers to the most highly trained scientists and technicians from all parts of the United States and from Canada, Great Britain, and many other countries. While the majority of its employees were civilians, representatives from all the military services were assigned to it. And in terms of total number of workers employed, Manhattan was one of the single largest wartime enterprises.

Less than two years after the Army took over active administration of the project, Manhattan was employing nearly 129,000 persons in its various operations. This peak figure, reached at the end of June 1944 when construction activity on the fissionable materials production plants was at a height, included contractor employment of 84,500 construction workers and 40,500 operating employees. In addition, there were slightly fewer than 1,800 military personnel assigned to the project and an equal number of civil service employees. Although construction activity gradually declined after the summer of 1944, total employment on the atomic project would continue at more than 100,000 into the summer of 1945, with military personnel reaching a peak of about 5,600 in the fall of that year.[1]

In recruiting and holding this vast work force, especially during the midwar period when competition for manpower from other important wartime programs was intense, Manhattan had to contend with a number of serious difficulties. Many of the skills the atomic project required were in chronic short supply; location of the major production plants in relatively remote areas with limited housing, inadequate transportation, and sparse population compounded existing manpower procurement obstacles; and the increasingly stringent requirements of the Selective Service System threatened to take away virtually irreplaceable technically trained workers at the most critical juncture in project operations. Even Manhattan's eventual attainment of the highest priority among wartime programs recruiting personnel with scarce skills did not completely compensate for the many problems.[2]

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[1] MDH, Bk. 1, Vol. 8, "Personnel," pp. 1.1-1.2 and Apps. A1, A1.1, A13 (Chart, Mil Personnel Strength, MD, Jul 42-Dec 46), DASA.

The Manhattan Project, as other World War II employers, operated in general compliance with existing labor laws, regulations, and policies, modified in certain instances to meet the exigencies of wartime conditions. Among those most affecting the program were the Davis-Bacon Act, the Convict Labor Law, the Eight-Hour Law, the Fair Labor Standards Act, the National Labor Relations Act, the Selective Training and Service Act, the Building and Construction Trades Wage Stabilization Agreement, and the "Little Steel" Formula. There were also the various modifications of these basic statutes and regulations embodied in executive orders and engineer directives. The single most important modifying factor in the project's adherence to existing manpower laws and regulations was its requirement for the most rigid security in all of its operations. Thus, for example, the Manhattan District placed strict limitations on union activities, established special grievance procedures in lieu of public hearings by the National Labor Relations Board, and provided its own internal administration of the Fair Labor Standards Act.[3]

Personnel Organization

Until mid-1942, Manhattan's manpower problems were limited primarily to recruiting scientific and technical personnel. The National Research Council, under its contract with the National Defense Research Committee (NDRC), had established the Office of Scientific Personnel in the spring of 1941, primarily to assist those wartime programs requiring scientifically trained persons. But as the demand rapidly increased, more drastic measures were needed to ensure an efficient and equitable employment of scientific manpower. Accordingly, Vannevar Bush, as head of the Office of Scientific Research and Development (OSRD), had appointed the Committee on Scientific Personnel. This committee, which held its first meeting in June 1942, not only recommended measures for securing scientific personnel but also actively assisted OSRD contractors in such matters as determining proper rates of compensation for scientific employees, securing deferments from military service for them, and recruiting additional scientists.[4]

The decision to proceed with construction of the production plants brought a major change in the atomic program's manpower requirements. Henceforth, the emphasis became one of fulfilling requirements for a complex industrial enterprise. Project recruiters now had to procure many engineers and technicians, tens of thousands of skilled and unskilled workers from the ranks of American labor, and the additional administrative personnel, both civilian and military, requisite to managing the far-flung activities of this vast new army of atomic employees.[5]

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[2] Ibid., pp. 1.1–1.2, DASA; Memo, Groves to Und Sec War, sub: MD's Labor Problems, 1 Nov 43, HB Files, Fldr 80, MDR; Groves, *Now It Can Be Told*, pp. 98–101; Ltr, Arthur L. Hughes (Personnel Dir, Los Alamos Lab) to Samuel T. Arnold (MD Consultant for Tech Personnel), 15 Jan 44, Admin Files, Gen Corresp, 201 (Gen), MDR. The subject of the letter concerned the effect of the changes in the Selective Service regulations on the laboratory's scientific staff.

[3] For an analysis of applicable statutes, regulations, and policies relating to manpower in World War II see MDH, Bk. 1, Vol. 8, App. B1, DASA. For an example of a District modification of an existing policy on grievance procedures see Ltr, Dist Engr to All Operating Contractors, CEW, 27 Sep 44, copy in ibid., App. B11, DASA.

[4] Stewart, *Organizing Scientific Research for War*, pp. 256–57.

The Army continued the OSRD practice of delegating most recruitment activities to project contractors. Generally speaking, Manhattan recruited only the District headquarters staff of specialists, whose primary role in manpower procurement was to assist project contractors and the hundreds of firms that supplied essential equipment and services to the project. The District personnel staff devoted considerable time to such measures as wage adjustments and improvement of working conditions that contributed to procurement and maintenance of an adequate work force. More often than not the District's role was to serve as the liaison channel through which project contractors and suppliers could communicate with various governmental agencies, with labor unions, and with other wartime organizations that could provide assistance in the solution of manpower problems.[6]

Under the original organization of the district engineer's office, various personnel activities were distributed among several divisions. (*See Chart 1.*) The Military Personnel Section, which also carried on liaison with the Selective Service, constituted a part of the District's Administrative Division. The Labor Relations Section, which was concerned mostly with wage and salary schedules, formed part of the Service and Control Division and operated in combination with the Safety-Accident Prevention Section. Other departments administered routine personnel matters. Personnel problems from area engineers in the field were similarly distributed to the appropriate headquarters office for disposition.[7]

Following the move of the Manhattan District headquarters from New York to Oak Ridge in August 1943, the district engineer took steps to centralize the administration of many functions, including those relating to manpower. (*See Chart 2.*) He shifted the Military Personnel Section, including its Selective Service functions, from the Administrative to the Service and Control Division. This left the Administrative Division with supervision chiefly over civil service and other civilian personnel of the District and of the Clinton Engineer Works (the District headquarters had absorbed most functions of the Clinton Area Engineers Office when it moved to Oak Ridge). Finally, in February 1944, the district engineer created a separate Personnel Division, placing in it all those manpower functions hitherto carried out by the Service and Control Division. To provide more assistance to area engineers and contractors as manpower problems reached a peak, both the Selective Service and the Labor Relations Sections of the new Personnel Division opened field offices in New York,

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[5] Smyth *Report*, p. 83; Memo, Bush to Conant, sub: Tube Alloys Prgm, 19 Jun 42, HB Files, Fldr 6, MDR.

[6] Marshall Diary, 19 and 27 Jun 42, OCG Files, Gen Corresp, Groves Files, Misc Recs Sec, behind Fldr 5, MDR; Groves, *Now It Can Be Told*, pp. 12–13; DSM Chronology, 26 Sep 42, Sec. 15(b), OROO.

[7] MDH, Bk. 1, Vol. 8, App. A2, DASA; Org Chart, U.S. Engrs Office, MD, Aug 43, Admin Files, Gen Corresp, 020 (MED-Org), MDR.

Chicago, and Oak Ridge, and at Pasco, Washington, near the Hanford Engineer Works.[8]

Organizational arrangements at field installations did not conform to any set pattern. Each area engineer or post commander set up the type of organization required for the kind of personnel needed to perform the work in progress at his installation. At the Hanford Engineer Works, for example, where manpower requirements resembled those at the Clinton Engineer Works, the area engineer established an organization similar to that in Oak Ridge. A large labor relations section worked in close coordination with Du Pont and local labor officials in the recruitment and employment of thousands of construction and production workers. A smaller personnel section dealt with problems relating to employees of the area engineer's office.[9]

At the Los Alamos Laboratory and the University of Chicago's Metallurgical Laboratory, the work force consisted primarily of civilian scientists and technicians employed under university contracts, a few civil service employees, some military personnel, and a varying number of workers brought in by construction and service contractors. Because there were no large production plants at either site, labor relations with construction and production workers constituted only a minor administrative problem. At Los Alamos, which the Army administered as a military post, the post commander established a small civilian personnel section in his administrative office to deal with nonmilitary manpower problems and to assist J. Robert Oppenheimer, the civilian project director, in recruiting scientists, technicians, and other specialists. At the Metallurgical Laboratory, manpower problems were similar to those at Los Alamos, except that there were fewer military personnel. The area engineer for the laboratory designated the personnel staff in his office as the Deferments Branch, which was indicative of its primary function.[10]

Neither the district engineer nor the area engineers by themselves could solve some of the most crucial manpower problems. Procurement of industrial workers with scarce skills, recruitment of scientific and technical specialists, and obtaining deferments for key personnel were examples of manpower problems so vitally related to the entire war effort that they could not be adequately dealt with except through officials who controlled the nationwide recruitment and employment of manpower. Consequently, General Groves made his personal headquarters in Washington, D.C., available as a liaison point through which project personnel officials at District headquarters and in the field installations could channel manpower problems to appropriate Washington officials or agencies. More often than not, the Manhattan commander himself would take the initial steps.[11]

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[8] Org Charts, U.S. Engrs Office, MD, Aug 43–Jan 45, MDR; MDH, Bk 1, Vol. 8, pp 1.4–1.5 and App A3, DASA.

[9] MDH, Bk. 4, Vol. 5, "Construction," pp. 4.1–4.26, 12.3–12.4, App. B57, DASA.

[10] Ibid., Vol. 2, "Research," pp. 7.1–7.3 and Apps. B5 and B8, and Bk. 8, Vol. 1, "General," Apps. B2 and B3, DASA.

[11] For examples of Groves's frequent personal involvement in manpower procurement problems see

Continued

General Groves was able to deal effectively with the problems of wartime manpower without building up a complex organization in his own office because he could secure assistance whenever he needed it from manpower specialists in the Office of the Under Secretary of War, the Army Service Forces' (ASF) Industrial Personnel Division, and the Office of the Chief of Engineers (OCE). Also, in matters pertaining to military personnel, he could channel project requests directly to Lt. Gen. Brehon B. Somervell, the ASF commander. Furthermore, through these various War Department channels Groves had ready access to union leaders, manpower officials in federal agencies, and others who controlled important elements of the country's manpower pool.[12]

Manpower procurement activities of the atomic project generally fell into three major categories: the quest for scientific and technical personnel, nationwide recruitment of industrial labor, and securing military and civilian administrative personnel. Each aspect of manpower procurement presented its own special problems and the Army administrators of the project would devote a considerable amount of time and energy to their resolution.[13]

Scientific and Technical Personnel

Even though there was a decrease in research and development activities after mid-1942, the need for more scientists and technicians did not decline proportionately. Because of the highly technical and unusual character of the laboratory-devised methods for producing fissionable materials, the firms engaged in building the production plants had to rely upon the project's research organizations for the technological knowledge to design, engineer, test, and operate the plants. Not only did these research organizations have to solve many crucial technical problems of plant construction and operation, they also had to supply from their own staffs on a more or less permanent basis many of the experts who supervised the equipping and operation of the plants.[14]

In addition to maintaining the staffs of these existing research organizations at a reasonable level of efficiency during 1943, Manhattan recruiters had to find scientists and technicians to staff an entire new research and development center operating under a University of California contract, the Los Alamos Laboratory in New Mexico. At the peak of its activities in 1945, this installation required more than seven hundred scientifically trained persons on its staff. While many of the division and group leaders came from the project's other research organizations, many of the technicians and junior scientists and

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correspondence in HB Files, Fldr 80, MDR, and Ltr, Tolman to Groves, 26 Jul 43, Admin Files, Gen Corresp, 231.2 (Physicists), MDR.

[12] Groves, *Now It Can Be Told*, pp. 99–101; Ltr, Marshall to Robins, 16 Nov 42, Admin Files, Gen Corresp, 231.2, MDR. Typical examples of Groves's employment of manpower specialists in the Under Secretary of War's office to expedite solution of personnel problems on the Manhattan Project may be found in HB Files, Fldrs 51, 79, and 80, MDR.

[13] MDH, Bk. 8, Vol. 1, pp. 2.1–2.2 and 7.1–7.2, DASA.

[14] See Chs. VI–IX. See also Compton, *Atomic Quest*, pp. 170–74 and 184–85.

some of the most important senior personnel were newly recruited.[15]

By 1943 junior scientists, typically graduate students with little or no practical experience, were about the only available scientifically educated manpower, and many of them were subject to the draft. In fact, a large number of the young scientists who came to work for the project after 1943 were already in uniform or, shortly after joining the atomic program, were called into service and assigned to the project's Special Engineer Detachment.[16]

During the OSRD's administration, each research and development organization had recruited its personnel with assistance and guidance from the OSRD's Committee on Scientific Personnel. The Army continued essentially the same policy, with General Groves and the project's Washington Liaison Office replacing the Committee on Scientific Personnel as the chief channel through which the directors of Manhattan's research organizations could obtain assistance in difficult cases. The Manhattan commander, for example, often intervened directly with government or academic manpower officials to ensure an adequate staff for the new Los Alamos Laboratory, or to aid Manhattan contractors in obtaining technical personnel. Because most personnel in these categories already were employed on other important wartime projects, Groves frequently had to seek assistance at the highest levels to secure their transfer to the Manhattan Project.[17]

One method that proved to be most effective was a direct communication—usually a letter—from Groves to the appropriate university administrator, corporation president, or government agency head, pointing out the vital character of the atomic program and requesting the release or loan of scientists to the Manhattan Project. In other instances, Groves enlisted the aid of OSRD Director Vannevar Bush or Harvey Bundy, special assistant to Secretary Stimson, and, through Bundy, of the Secretary himself. Stimson, for example, was instrumental in recruiting Norman F. Ramsey, the radar specialist who helped design the atomic bomb.[18]

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[15] MDH, Bk. 8, Vol. 2, "Technical (Project Y History)," App. Graph No. 2, DASA; Ltr, Groves to Bush, 20 Apr 44, Admin Files, Gen Corresp, 231.2 (Scientists), MDR; Memo, Maj Peer de Silva (Mil Intel Br chief, Los Alamos Lab) to Groves, sub: Procurement of Scientific Personnel, 27 Sep 44, Admin Files, Gen Corresp, 201 (Gen), MDR.

[16] MDH, Bk. 8, Vol. 2, p. III.17, DASA. On procurement of scientists from other wartime projects see MDR, HB Files, Fldr 24, correspondence relating to radar specialist Norman F. Ramsey, and Ltr, Styer to W. M. Peirce (New Jersey Zinc Co., Palmerton, Pa.), probably Sep 43, MD, 1942–45, Somervell Desk File, ASF.

[17] Ltr, Oppenheimer to Isidor I. Rabi (Rad Lab, MIT), 26 Feb 43, Admin Files, Gen Corresp, 161 (Univ of Calif), MDR. See also Groves's letters in Admin Files, Gen Corresp, 231.2 (Scientists), MDR.

[18] Numerous examples of the extensive correspondence by Groves and others on the procurement of scientists for the Manhattan staff are in Admin Files, Gen Corresp, 231.2 (Scientists), MDR. On the recruiting of Ramsey see HB Files, Fldr 24, MDR, for Memo, Edward L. Bowles (consultant to Secy War) to Bundy, sub: Dr. Norman F. Ramsey, 12 Jun 43; Memo, Groves to Bundy, sub: Need for Dr. Norman F. Ramsey, 5 Jul 43; Memos, Bundy to Bowles, 7 Jul and 19 Aug 43; Memo, Bundy to Secy War, 10 Sep 43; Memo for File, unsigned (probably Bundy), 14 Sep 43. See MD, 1942–45, Somervell Desk File, ASF, for Memos, Styer to Groves, 18 and 23 Sep 43. In the same file is General Styer's correspondence on the recruitment of scientists already in military service. See Memo, Styer to Brig Gen Joseph N. Dalton (Act Chief of Staff, Personnel, SOS), 9 Feb 43; Memo, Groves to Styer, sub: Assignment of Capt O. H. Greager, CWS, to MD,

Continued

Groves also turned often to his military and scientific advisers. Both Maj. Gen. Wilhelm D. Styer and Rear Adm. William R. Purnell of the Military Policy Committee assisted in securing scientists and technicians in active military service. Richard C. Tolman and James B. Conant were instrumental in procuring a number of key scientists for the Los Alamos project. Tolman drew up for Groves a comprehensive list of all atomic scientists in the United States and had them rated by scientists already assigned to the atomic project as to their ability, experience, qualities of leadership, and availability. Conant played an important part in persuading George B. Kistiakowsky, an explosives expert on the NDRC staff, to leave this position for one at Los Alamos and then in assisting him to secure additional scientists for his implosion research team at the laboratory. Supplementing the efforts of Tolman and Conant was Dean Samuel T. Arnold of Brown University, a chemist by training, engaged in 1943 as a consultant to recruit technical personnel at educational institutions.[19]

By late 1944, the Manhattan Project was employing virtually all available specially trained personnel. Hence, the only solution to answering the specific needs of the various project installations was to transfer scientists from one area to another area of the atomic program. For example, when Oppenheimer requested approximately fifty scientists holding a doctor of philosophy degree in physics, or its equivalent, to staff a major new division at the laboratory, he suggested that this number was available in the Metallurgical Project, serving as standby crews for the Hanford plant. After consultations with Metallurgical Project Director Arthur Compton, Groves directed him to release the fifty physicists from his program. By December 1944, Compton had complied, but only by placing on a virtual standby all research and development activities related to physics at the Clinton, Argonne, and Metallurgical laboratories.[20]

Industrial Labor

As in the procurement of scientific and technical personnel, the Manhattan Project employed a variety of methods and drew upon many sources in recruiting both skilled and unskilled labor. For assistance in procuring skilled construction workers and some maintenance personnel (carpenters, bricklayers, electricians,

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9 Feb 43; Memo, Groves (for Reybold) to Styer, sub: Transfer of 2d Lt Rollin D'Arcy Morse, 5 Mar 43.

[19] On Kistiakowsky see Ltrs, Capt William S. Parsons (Ord Div chief, Los Alamos Lab) to Conant, 19 Feb 44, Groves to Bush, 20 Apr 44, and Kistiakowsky to Groves, 1 May 44, Admin Files, Gen Corresp, 231.2 (Scientists), MDR. On other aspects of the program to recruit scientists see Memo, Parsons to Lt Col Whitney Ashbridge (CO, Los Alamos Lab), 23 Jun 44, Admin Files, Gen Corresp, 620 (Santa Fe), MDR, and Hewlett and Anderson, *New World*, p. 247. Two versions of Tolman's list appear in Admin Files, Gen Corresp, MDR: the first, undated (probably Jul 43), is in 201 (Gen); the second, Incl to Ltr, Tolman to Groves, 26 Jul 43, is in 231.2 (Physicists). On Dean Arnold see MDH, Bk. 1, Vol. 8, p. 2.3, DASA.

[20] Memo, de Silva to Groves, sub: Procurement of Scientific Personnel, 27 Sep 44; Ltrs, Groves to Compton, 31 Oct 44, and Compton to Groves, 7 Dec 44. All in Admin Files, Gen Corresp, 201 (Gen), MDR. See also Ltr, Compton to Groves, sub: Transfer of Physicists to Proj Y, 6 Oct 44, Admin Files, Gen Corresp, 230.35 (Changes of Station and Transfer), MDR.

pipe fitters, mechanics, and related trades), Manhattan turned to the unions comprising the Building and Construction Trades Department of the American Federation of Labor. For unskilled or common labor and some semiskilled personnel (cafeteria employees, plant operation trainees, and similar job categories), it depended primarily upon recruiters hired by project contractors or by the Army, who followed regular routes established by the War Manpower Commission in their search for available workers. Supplementing these recruiters, but a far less productive source, were the offices of the United States Employment Service in each important employment center. Finally, for much of the manpower that supervised work forces for both plant construction and operation, the project relied upon personnel furnished directly by the major contractors.[21]

Manhattan's multifaceted and far-ranging quest for workers was necessary because, by 1943, when the project was beginning its large-scale procurement of construction labor, the nation had used up the large pool of unemployed carried over from the Depression and was experiencing an actual labor shortage. Project recruiters had anticipated problems at the Hanford Engineer Works because it was located in Region XII of the War Manpower Commission, an area that long had had serious labor shortages. But they were surprised when a severe shortage of common labor developed at the Clinton Engineer Works where contractors were recruiting from Region VII (Alabama, Florida, Georgia, Mississippi, South Carolina, and Tennessee), an area that still had a labor surplus. Nevertheless, by June, lack of some three hundred laborers was jeopardizing the construction schedule at Clinton, and the indications were that neither the common laborers' union nor the regular itinerant recruiters working through the U.S. Employment Service were going to be able to procure the additional numbers needed.[22]

For a solution, General Groves looked to manpower agencies in Washington, D.C. Using War Department channels, specifically Under Secretary of War Robert P. Patterson's office and the ASF's Industrial Personnel Division, he negotiated with officials of the War Manpower Commission. His objective was to secure a change in certain commission practices. One such practice was the reluctance of its field organization to permit Manhattan recruiters to interview prospective workers in regions other than those in which atomic facilities were located until all local and regional employment needs in those other regions had been met. Another was what Groves claimed was its tendency to route Manhattan's itinerant recruiters to small towns where few prospective workers were available, rather than to the cities where there was a surplus of labor. Du Pont officials at Hanford also had complained to Groves about this inconsistency in policy, "necessitating recruitment in a certain manner in one town and in a different manner in a similar nearby town." [23]

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[21] MDH, Bk. 1, Vol. 8, pp. 2.2–2.5, DASA. For specific accounts of contractor participation in labor recruitment see Completion Rpt, Du Pont, sub: Clinton Engr Works, TNX Area, Contract W–7412–eng–23, 1 Apr 44, pp. 73–93, OROO; Completion Rpt, Stone and Webster, sub: Clinton Engr Works, Contract W–7401–eng–13, 1946, pp. 144–45, OROO; Du Pont Constr Hist, Vol. 1, pp. 50–67, HOO. See also Ltr, M. W. Kellogg (Kellogg Co. president) to Groves, 9 May 45, Admin Files, Gen Corresp, 231.21 (Kellex), MDR.

[22] Byron Fairchild and Jonathan Grossman, *The Army and Industrial Manpower*, U.S. Army in World War II (Washington, D.C.: Government Printing Office, 1959), pp. 55 and 255–56; Robert R. Palmer, Bell I. Wiley, and William R. Keast, *The Procurement and Training of Ground Combat Troops*, U.S. Army in World War II (Washington, D.C.: Government Printing Office, 1948), pp. 36–37, 45, 503; MDH, Bk. 1, Vol. 8, pp. 2.3–2.4 and App. A1, DASA; Memo, Maj Warren George (Clinton Area Engr) to Dist Engr, sub: Labor Supply–Apparent Inability To Supply Required Labor, 25 Mar 43, OROO; Memo for File, Labor Rels Sec, same sub, 22 Mar 43, OROO; Du Pont Constr Hist, Vol. 1, p. 50, HOO.

As an immediate result of Groves's negotiations with the Manpower Commission, the Manhattan Project in late summer of 1943 received a very limited and temporary priority for recruiting common labor. Taking care to maintain very strict control over what was to be the first wartime instance of establishing a system of priorities in manpower recruitment, the commission assigned a special representative to the Manhattan District, giving him authority to issue certificates of availability to potential recruits for the project's common labor force. The representative could issue the certificates only to workers employed in nonessential jobs. Armed with these certificates, workers could leave their nonessential employment and go to work for Manhattan even though their employers were opposed to the move. At the same time, the Manpower Commission directed that all workers in the common labor category who had looked for employment through the U.S. Employment Service should be referred first to interviewers of Manhattan District contractors. When even these priority arrangements failed to secure all the common laborers needed, the commission authorized Manhattan recruiters to seek workers on a temporary basis in areas immediately adjacent to Region VII. The manpower priority system applied initially only to recruiting for the Clinton Engineer Works, but in September 1943 the commission also granted similar privileges to recruiters seeking common labor for the Hanford Engineer Works in Region XII.[24]

The Manpower Commission's special concession only temporarily relieved the project's labor recruiting problems. In late 1943 and early 1944, when requirements for both construction and production workers mushroomed, the atomic installations developed new manpower shortages. By April 1944, General Groves estimated that the project required an additional ten thousand construction workers at the main production plants and more than eighteen hundred research personnel at the research laboratories. He noted that the major deficiencies were a shortage of four thousand common laborers and twelve hundred operating personnel at Clinton and Hanford, respectively, and, in addition, of eight hundred millwrights at the latter site. The chief of the Labor Branch of ASF's Industrial Personnel Division, Lt. Col.

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[23] Du Pont Constr Hist (source of quotation), Vol. 1, p. 67, HOO; Memo, Groves to Und Secy War, sub: MD's Labor Problems, 1 Nov 43, MDR; Memo, W. D. S. (undoubtedly Maj Gen W. D. Styer) to [James] Mitchell (Industrial Personnel Div Dir, ASF), 7 Dec 43, MD, 1942–45, Somervell Desk File, ASF; Memo, Patterson to Groves, 14 Feb 44, HB Files, Fldr 80, MDR.

[24] MDH, Bk. 1, Vol. 8, pp. 2.3–2.4, DASA; Du Pont Constr Hist, Vol. 1, p. 52, HOO.

John K. Collins, confirmed Groves's figures for the Clinton Engineer Works after an inspection trip there in May, adding the further observation that, as a result of the shortage, some seventeen hundred carpenters were doing laborers' work at carpenters' wage rates. Colonel Collins cited, too, the need for electricians, estimating the requirements to be twenty-five hundred—more than twice the number Groves had mentioned.[25]

In spite of these shortages, General Groves remained optimistic that the atomic program had a good chance to produce a bomb during the first part of 1945, provided that the project continued to have the "highest priority in supplies, personnel, and equipment." [26] When the Manhattan commander expressed this view at a meeting of the Combined Policy Committee, Secretary Stimson, who was presiding, assured him that the project would continue to have first priority in manpower recruitment. In March 1944, the War Production Board placed Manhattan at the top of its list of the twelve most urgent programs currently in progress. Then in November 1944, the War Manpower Commission further strengthened Manhattan's top-priority position by awarding the project the highest category under its system for priority referral of workers seeking jobs through the U.S. Employment Service.[27]

Manhattan, however, did not rely solely upon a high-priority rating. Working in close coordination with labor officials in Under Secretary of War Patterson's office, the District arranged for assignment of special recruiting teams to Clinton and Hanford, composed of eight or nine military officers from the Manpower Commission, the ASF's Industrial Personnel Division, and the Corps of Engineers. Special representatives designated by the commission and the War Department coordinated the activities of the teams and provided them with a direct channel of communication to Washington manpower agencies. Because of the success of these special military teams, Manhattan continued to use them well into 1945. In late 1944, for example, the Los Alamos Laboratory desperately needed 190 additional machinists and toolmakers, a category of skilled workers always difficult to recruit. The District organized several teams—each composed of an Army officer, a professional recruiter, and a security agent—and dispatched them into six manpower areas (Regions I, II, III, V, VI, and VII). In less than a month they had procured all of the machinists and toolmakers required by the New Mexico installation.[28]

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[25] Table (Schedule of Estimated Labor Requirements for All Constr Contractors, 1 Dec 43–1 Jul 44, CEW), Incl to Memo, Lt Col Thomas T. Crenshaw (Ex Off, CEW) to Groves, sub: Labor Forecast, 11 Dec 43, Admin Files, Gen Corresp, 201 (Gen), MDR; Memo, Lt Col John K. Collins (Labor Br Chief, Industrial Personnel Div, ASF) to Groves, sub: Visit to Clinton Engr Works (16–17 May 44), 22 May 44, HB Files, Fldr 79 (Jack Madigan), MDR; Du Pont Constr Hist, Vol. 1, pp. 57–61, HOO.

[26] Memo, unsigned (undoubtedly Groves), after 13 Apr 44, HB Files, Fldr 109, MDR.

[27] MDH, Bk. 1, Vol. 8, pp. 2.4–2.5 and App. B6 (WMC Field Instruction No. 416, Supp. No. 2, to All Regional Manpower Dirs, sub: Establishment of Categories of Employer Orders for Priority Referral and Factors To Be Considered in Determining Eligibility of Orders for Priority, 27 Nov 44), DASA; CPC Min, 13 Apr 44, DS; Fairchild and Grossman, *Army and Industrial Manpower*, pp. 30, 146–49, 200

[28] Outline for WD-WMC Mtg Re MD Projs, 25 Apr 44, HB Files, Fldr 79 (Jack Madigan), MDR;

Continued

Procurement of certain types of essential skilled labor, such as pipe fitters and electricians, defied efforts of even special recruiting teams, and other measures had to be instituted. When construction at Hanford in the summer of 1944 required several hundred additional pipe fitters, Du Pont, the prime contractor, and the International Association of Plumbers and Pipe Fitters jointly launched a major recruiting effort, even though the absolute unavailability of pipe fitters in the civilian labor market foredoomed them to failure. There were, however, many soldiers with this skill in Army units stationed in the United States. Consequently, Secretary Stimson directed Army Chief of Staff Marshall to transfer 200 enlisted men with pipe fitting skills into the Enlisted Reserve Corps for a period of 90 days (subsequently extended to 180 days). The soldiers had to be in limited service status, that is, not qualified for overseas duty, and willing to work at Hanford. By early September, the first of an eventual total of 198 military pipe fitters were reporting for duty at the plutonium site.[29]

About the same time, a shortage of some twenty-five hundred electricians was seriously jeopardizing meeting construction schedules at both Hanford and Clinton, and project recruiters indicated to General Groves that there was little likelihood of obtaining them through normal employment channels. In this emergency the Manhattan commander once again turned to Under Secretary of War Patterson's office for assistance. Patterson immediately got in touch with Edward J. Brown, president of the International Brotherhood of Electrical Workers, and Laurence W. Davis, manager of the National Electrical Contractors Association, as well as officials at the War Manpower Commission. In due course he and Groves worked out an agreement with these organizations, the so-called Patterson-Brown Plan, by which Manhattan had authority to borrow for a ninety-day period electricians already employed on jobs not essential to the war. To make the plan attractive, there was provision for payment of travel expenses and a guarantee that the individuals would not lose their seniority rights and could return to their previous place of employment after completing ninety days of service on the atomic project. To encourage cooperation of employers, the plan provided that all organizations that released electricians to work at Hanford or Clinton would receive official recognition. A news release from Patterson's office gave the plan wide publicity in the newspapers, and General Styer requested the appropriate Army service commands to furnish whatever assistance they could. In a few months, this novel solution supplied the electricians needed to meet both Hanford and Clinton construction deadlines.[30]

MDH, Bk. 1, Vol. 8, pp. 2.6–2.7, DASA; Memos, Brig Gen Edward S. Greenbaum (Ex Off for Und Secy War) to Capt Walker E. Stagg et al., 13 and 18 Nov 44 and 20 Apr 45, HB Files, Fldr 80, MDR. These memos, prepared by the District and approved by Groves, detailed the specified individuals to undertake a special recruitment program.

[29] MDH, Bk. 4, Vol. 5, pp. 4.8–4.9, DASA; Groves, *Now It Can Be Told*, p. 101; Du Pont Constr Hist, Vol. 1, pp. 64–65, HOO.

[30] MDH, Bk. 1, Vol. 8, p. 2.6 and App. B7; Bk. 4, Vol. 5, pp. 4.7–4.8; and Bk. 5, Vol. 5, "Construction," pp. 5.1–5.2, DASA. Ltrs, Patterson to Brown and to Davis, 21 Jun 44, and Patterson to CG's of

Continued

After the fashion of the fringe benefits of the Patterson-Brown Plan, project recruiters frequently offered special inducements to attract persons with critical skills, usually in the form of payment of all or part of a worker's transportation costs in traveling to Hanford or Clinton, a guarantee of housing (but usually not for family), and furnishing recreational and other community facilities. On occasion, Manhattan applied to the National War Labor Board for modification or adjustment of the prevailing wage rates. Thus, in July 1943, Under Secretary of War Patterson secured a wage rate increase ($0.50 to $0.575 an hour) for common labor at the Clinton Engineer Works and, a year later, one for skilled maintenance workers, especially electrical repairmen and machinists. The latter increase was necessary because these workers could earn a higher wage at construction jobs, at TVA installations, and at some of the major war industries in the local area than as employees of the atomic plants.[31]

Civilian and Military Personnel

Although most Manhattan workers were employees of project contractors, two important groups were not: civil service employees at District headquarters and in the several area offices, and military personnel serving on the District staff, in the area offices, and in the various military units. Combined numbers of these two groups, even at the height of project activities, amounted to considerably less than 10 percent of the Manhattan Project's total manpower. But because many members of these groups held key positions in administration and operations, they exercised an influence over the course of the atomic bomb program far out of proportion to their relatively small numbers.

MILITARY AND CIVILIAN WORKERS AT CEW

From the start of its administration of the project, the Army employed civilians in staff positions at both the District and area levels. Generally, they served in positions requiring special administrative or technical knowledge and experience, such as

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2d, 5th, 6th, and 7th Svc Cmds, 5 Jul 44, HB Files, Fldr 51, MDR. Ltr, Maj Gen Thomas G. Terry (CG 2d Svc Cmd) to Act Secy War Patterson, 10 Jul 44, HB Files, Fldr 80, MDR. Groves, *Now It Can Be Told,* p. 99. Du Pont Constr Hist, Vol. 1, p. 65, HOO.

[31] MDH, Bk. 1, Vol. 8, p. 3.4, DASA; Memo, Patterson to Groves, 14 Feb 44, and Ltr, Patterson to William H. Davis (NWLB chairman), 12 Jun 44, HB Files, Fldr 80, MDR; Ltr, Greenbaum to Fred M. Vinson (Office of Economic Stabilization Dir), 26 May 44, and Statement on Requested Increase in Operating Rates at CEW, attached to covering Memo, 14 Jun 44, HB Files, Fldr 51, MDR; Du Pont Opns Hist, Bk. 1, pp. 1 and 4, HOO.

those relating to finance, insurance, safety, contracts, and office management, as well as in jobs that women could fill. Most were recruited through regular civil service channels or were transferred to the Manhattan Project from other government agencies. When Colonel Marshall formed the original Manhattan District headquarters organization, he primarily recruited civilian employees who were members of his former Syracuse (New York) District staff. Included in this group were a number of veteran Corps of Engineers civilians who, as the District headquarters expanded, received military commissions. The District continued to hire additional civil service employees, securing many from other engineer projects, from other government agencies, and from the civilian staffs of the other military services. Project area engineers also followed similar policies in forming their local administrative staffs.[32]

For reasons of security and for convenience, the District carried its civilian workers on its employment roles as if they were regular engineer employees. While this arrangement facilitated administrative aspects, it subjected the District to all wartime manpower regulations. For example, the presidental proclamation of December 1942 suspended the eight-hour day and that of February 1943 established a 48-hour workweek for all full-time workers in areas of labor shortage. Consistent with these regulations, the War Department provided in May that its civilian employees could work a six-day, 48-hour week, receiving overtime pay for work on Sunday or beyond eight hours on a weekday, and the District adopted this policy in June, including in it a provision for overtime work up to sixty-four hours a week when specific emergency situations required it. In actual practice, only lower-salaried employees received overtime pay. Higher-paid employees, such as section and division chiefs, who put in overtime did so voluntarily, without additional compensation.[33]

An unforeseen disadvantage of this administrative arrangement was that the District also had to conform with OCE manpower ceilings, as required by the ASF or the War Department. Thus in the hectic summer of 1943, when the project was on the threshold of rapid expansion, OCE personnel officials notified General Groves that the District must reduce its personnel by some 13 percent. The Manhattan commander immediately registered vigorous objection. General Styer interceded with OCE officials, who then arranged to have other engineer agencies absorb the staff reductions prescribed for the Manhattan District. A year later, OCE personnel authorities again informed the District that substantial reduction in both civilian and military personnel

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[32] List of Key Personnel, MD Area Offices (ca. Nov 44), Admin Files, Gen Corresp, 231.001 (LC), MDR; Marshall Diary, 21-23 Jun 42, MDR; Org Charts, U.S. Engrs Office, MD, 1 Nov 43, 15 Feb and 10 Nov 44, MDR.

[33] Presidental Proclamation, sub: Suspension of Eight-Hour Law as to Laborers and Mechanics Employed by WD on Public Works in the United States, 28 Dec 42; WD Orders H, sub: Hours of Work and Overtime Compensation for Civilian Employees, 14 May 43; MD Cir Ltr, sub: Hours of Work and Overtime Compensation for Civilian Employees, 11 Jun 43; Memo, Lt Col E. H. Marsden (Ex Off, MD) to Groves, 24 Aug 43. All in Admin Files, Gen Corresp, 201 (Gen), MDR.

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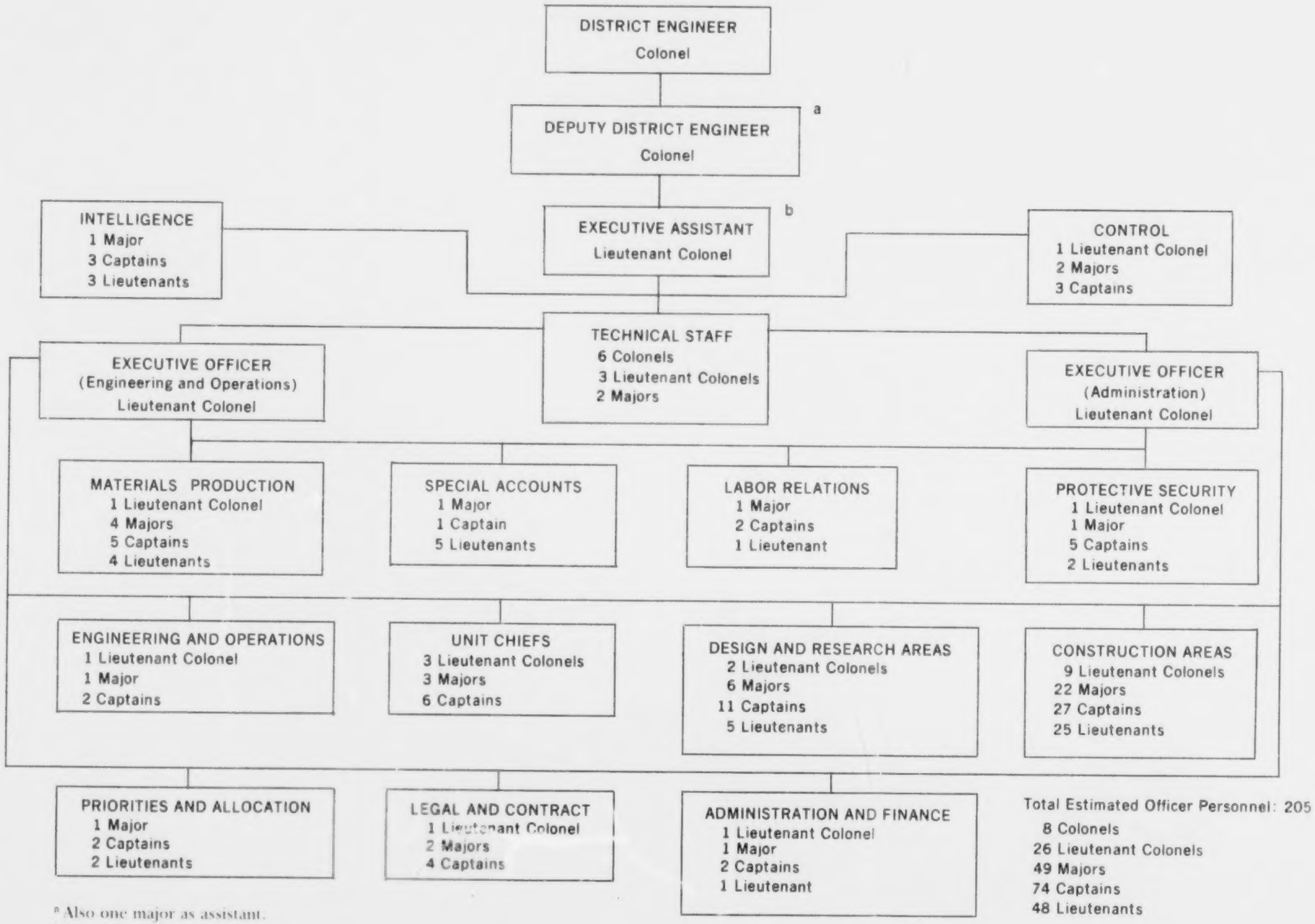
CHART 5—ESTIMATED OFFICER PERSONNEL REQUIREMENTS FOR THE MANHATTAN DISTRICT, JANUARY 1943


DISTRICT ENGINEER
Colonel
DEPUTY DISTRICT ENGINEER
Colonel
a
INTELLIGENCE
1 Major
3 Captains
3 Lieutenants
EXECUTIVE ASSISTANT
Lieutenant Colonel
b
CONTROL
1 Lieutenant Colonel
2 Majors
3 Captains
TECHNICAL STAFF
6 Colonels
3 Lieutenant Colonels
2 Majors
EXECUTIVE OFFICER
(Engineering and Operations)
Lieutenant Colonel
EXECUTIVE OFFICER
(Administration)
Lieutenant Colonel
MATERIALS PRODUCTION
1 Lieutenant Colonel
4 Majors
5 Captains
4 Lieutenants
SPECIAL ACCOUNTS
1 Major
1 Captain
5 Lieutenants
LABOR RELATIONS
1 Major
2 Captains
1 Lieutenant
PROTECTIVE SECURITY
1 Lieutenant Colonel
1 Major
5 Captains
2 Lieutenants
ENGINEERING AND OPERATIONS
1 Lieutenant Colonel
1 Major
2 Captains
UNIT CHIEFS
3 Lieutenant Colonels
3 Majors
6 Captains
DESIGN AND RESEARCH AREAS
2 Lieutenant Colonels
6 Majors
11 Captains
5 Lieutenants
CONSTRUCTION AREAS
9 Lieutenant Colonels
22 Majors
27 Captains
25 Lieutenants
PRIORITIES AND ALLOCATION
1 Major
2 Captains
2 Lieutenants
LEGAL AND CONTRACT
1 Lieutenant Colonel
2 Majors
4 Captains
ADMINISTRATION AND FINANCE
1 Lieutenant Colonel
1 Major
2 Captains
1 Lieutenant
Total Estimated Officer Personnel: 205
8 Colonels
26 Lieutenant Colonels
49 Majors
74 Captains
48 Lieutenants

[a] Also one major as assistant.

[b] Also one captain as assistant.

Source: Org Chart, U.S. Engrs. Office, MD, 23 Jan 43, OROO.

[illegible] PUBLIC LIBRARY

were necessary. Lt. Col. Charles Vanden Bulck, head of the District's Administrative Division, instructed area office and division and section heads to initiate appropriate measures, such as reassignment or separation of unsatisfactory workers and elimination of duplication of functions. By this time some personnel reduction in those staffs primarily concerned with site development and design and building of production facilities was possible, but operational activities were expanding rapidly, requiring enlargement of District and area staffs overseeing plant operations and bomb development. The net result was continued growth in total personnel, a trend that was to persist until the fall of 1945.[34]

Militarization of the atomic project did not begin until the summer of 1942 *(Chart 5)*. The first group of military personnel came to the newly activated Manhattan District as part of an OCE authorization of sixty-two officers, assigned primarily to fill key supervisory and administrative posts n the District headquarters and area offices. For many months, however, he number of active duty personnel remained small (as late as December 1943, no more than four hundred). Subsequently, additional authorizaions from OCE, ASF, and, in certain special cases, the Secretary of War himself, furnished a continuing inflow of officers and warrant officers. The majority came under a series of supplementary bulk allotments, but some were also included in personnel authorizations for military police, counterintelligence, Women's Army Corps (WAC),[35] and other units assigned to the project. The District procured some hard-to-secure specialists—for example, patent attorneys, engineers, chemists, and physicists—by obtaining authorization to have naval officers assigned to Manhattan and to commission qualified civilians directly. The District's Military Personnel Section in Oak Ridge remained in charge of the procurement and central administration of all project-commissioned personnel throughout the war, numbering more than six hundred by the summer of 1945 and stationed in many different parts of the United States as well as in several overseas areas.[36]

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[34] Memo, F. M. S. [Col Frank M. Smith, Asst to SF chief of staff] to Styer, 29 Jul 43, MD, 1942–45, Somervell Desk File, ASF. MD Bull, Vanden Bulck or Dist Engr) to Office, Div, and Sec Heads, sub: ecrease in Personnel, 19 Aug 44, Admin Files, MD irectives, MDR. MDH, Bk. 1, Vol. 12, "Clinton Enneer Works," App. C2 (Chart, Employment at EW); Bk. 4, Vol. 6, "Operation," App. B8 (Chart, mployment at HEW); and Bk. 8, Vol. 1, App. B7 Chart, Employment at Los Alamos Lab), DASA.

[35] On 30 Sep 43, the Women's Army Auxiliary Corps became a part of the Army of the United States and received its new official designation, Women's Army Corps. See Mattie E. Treadwell, *The Women's Army Corps*, U.S. Army in World War II (Washington, D.C.: Government Printing Office, 1954) pp. 218–30.

[36] MDH, Bk. 1, Vol. 8, pp. 7.3–7.4, 7.8, 8.1–8.3, App. A13, and Vol. 14, "Intelligence & Security," pp. 7.5–7.7, DASA; Org Charts, U.S. Engrs Office, MD, Aug 43–Jan 45, MDR; List, sub: MD Offs on Duty at Los Alamos and Their Duties, 6 May 44, Incl to Memo, Ashbridge to Groves, 14 Jun 44, Admin Files, Gen Corresp, 201 (Gen), MDR; Memo, Groves to CG SOS, sub: Org and Assignment of Mil Orgs, 28 Jan 43, Admin Files, Gen Corresp, 322 (Los Alamos), MDR; Memo, Groves to CG ASF, sub: Spec WAAC Det, MD, 31 May 43, Admin Files, Gen Corresp, 323.42 (LC), MDR; Memo, Groves to CG ASF, sub: Prov MP Det No. 1, 17 Mar 43, Admin Files, Gen Corresp, 231.001, MDR; Memos, Greenbaum to Bundy, sub: Patent Offs, 21 Feb 44, Groves to Bundy, same sub, and Personnel Div, G1, to TAG, sub: Procurement Objective for Chief of Engrs, 13 Apr 44, HB Files, Fldr 24, MDR; Memo, Bundy to Maj Gen Stephen G. Henry, G–1 (approving direct commissioning of second lieutenants for MD), 1 Sep 44, HB Files, Fldr 8, MDR.

Beginning in 1943, the District regularly requisitioned military personnel to carry out functions that, for reasons of security or lack of civilian manpower, could not be performed by civilian employees. In January, General Groves requested the Services of Supply (ASF's earlier designation) to allot military police, medical, and veterinary personnel for a special military police company to protect and service the highly secret operations at Los Alamos. In March, he asked for additional military personnel to form provisional military police, medical, and engineer detachments to be used at the other major project sites. The ASF promptly authorized the requested military manpower, providing for their activation and training at appropriate training centers of the 6th and 8th Service Commands.[37]

When rapid expansion created an urgent need for additional military personnel to handle classified mail and records, Groves requested the ASF to provide Manhattan with a detachment from the Women's Army Auxiliary Corps (WAAC) to perform that type of clerical work. The processing of mail and records at District headquarters, as well as at the Clinton, Hanford, and Los Alamos installations, Groves pointed out, provided such a broad view of project activities that it must be kept in the hands of personnel under strict military control. The 1st Provisional WAAC Detachment was activated at Fort Sill, Oklahoma, on 17 April, and a few days later an officer and six auxiliaries reported to Los Alamos. In June, the ASF authorized Manhattan's request for a total of three WAAC officers and seventy-five enlisted women, and in subsequent months granted the District substantial WAC allotments. In the period from 1943 through 1945, those WAC members assigned to units at Clinton, Hanford, Los Alamos, and other project installations worked not only as handlers of classified material but also at a great variety of other jobs, some of them highly technical and scientific.[38]

By spring of 1943, project leaders were anticipating problems in recruiting and holding younger technicians and scientists who were subject to military service. The obvious solution was to constitute a military organization within the Manhattan Project to which these technicians and scientists could be assigned. Accordingly, in May, the District established a Special Engineer Detachment (SED) and requested ASF authorization for an allotment of 675 men to form a headquarters element and four separate companies. Recruiting began in late 1943 through the Army Specialized Training Program, the National Roster of Scientific and Specialized Personnel in Washington, D.C., and

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[37] Memos, Groves to CG SOS, subs: Org and Assignment of Mil Orgs, 28 Jan 43, and Prov Engr Det No. 1, 11 Mar 43, 322 (Los Alamos) and 200.3, respectively; Memos, Groves to CG ASF, subs: Prov Engr Det No. 1, 29 Jul 43, and Prov Med Det No. 1, 12 and 17 Mar 43, 200.3 and 231.001, respectively. All in Admin Files, Gen Corresp, MDR.

[38] Memo, Groves to CG ASF, sub: Special WAAC Det, MD, 31 May 43 (and appended note, dated 2 Jun 43 and signed by Col F. M. Smith); Ind to ibid., Brig Gen Russel B. Reynolds (Mil Personnel Div chief, ASF) to Chief of Engrs, 3 Jun 43; Memo, Marsden to Groves, sub: Spec WAC Det, MD, 29 Dec 43. All in Admin Files, Gen Corresp, 323.42 (LC), MDR. Marsden Diary, 29 May and 3, 9, 17 Jun 43, OROO. Treadwell, *Women's Army Corps*, pp. 327-29, Unit Hist, WAC Det, 9812th Tech Svc Unit, CE, MD, copy in WAC Files, CMH.

WOMEN'S ARMY CORPS DETACHMENT AT CEW

universities and colleges in all parts of the country. Personnel officials also screened and interviewed qualified individuals in Army camps and directed inquiries to other government agencies and private industrial firms concerning former employees who were in the military service.[39]

The District assigned most of its scientific and technical enlisted personnel to the SED unit. In those instances, however, when the District had to place enlisted men on duty with private contractors or in small communities, it transferred them to the Enlisted Reserve Corps. This permitted the men to work in an inconspicuous civilian status yet to remain, for reasons of security, under military control. It also reduced the cost of military administration for small numbers of enlisted personnel stationed in outlying areas.[40]

In providing for the efficient and adequate administration of Manhattan Project enlisted personnel, whether in scientific and technical, clerical, housekeeping, or military intelligence and security units, the District encountered special problems. Some of these stemmed from the rapidity of increase in enlisted personnel—from several hundred in early 1944, to twenty-six hundred by year's end, and continuing up to a maximum total of

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[39] MDH, Bk. 1, Vol. 8. pp. 7.3–7.4 and App. C18, DASA; Msg, Marshall to Nichols, 18 May 43, Admin Files, Gen Corresp, 200.3 (SED), MDR.

[40] MDH, Bk. 1, Vol. 8, p. 7.4, DASA; Memo, Lt Col Curtis A. Nelson (Personnel Div chief, MD) to Groves, sub: Enlisted Reservists, 29 Aug 45, Admin Files, Gen Corresp, 220.3, MDR.

ENLISTED MEN AT CEW DURING OFF-DUTY HOURS, *studying U.S. Armed Forces Institute courses*

about five thousand by the fall of 1945. Other problems arose from the wide geographical distribution of enlisted personnel, making any effort to achieve effective centralized administrative control from District headquarters in Oak Ridge impracticable.[41]

Under normal circumstances, a solution would have been attachment of the District's scattered military units to the various area service commands for purposes of administration, but such arrangements presented a security risk. Consequently, the district engineer assigned responsibility for administering enlisted personnel to the commissioned officers at the larger sites and to the experienced noncommissioned officers at the remaining project locations, making them directly responsible to the District's Military Personnel Section in Oak Ridge. Administrative policies varied, depending upon conditions prevailing at each particular location. The policy on rations and quarters for enlisted personnel is illustrative. Enlisted men at all areas except Oak Ridge, Los Alamos, and Richland received a rental allowance in lieu of quarters. The same was true for rations, except at Los Alamos and Richland. Similarly, WAC enlisted personnel received a monetary allowance in lieu of both quarters and rations,

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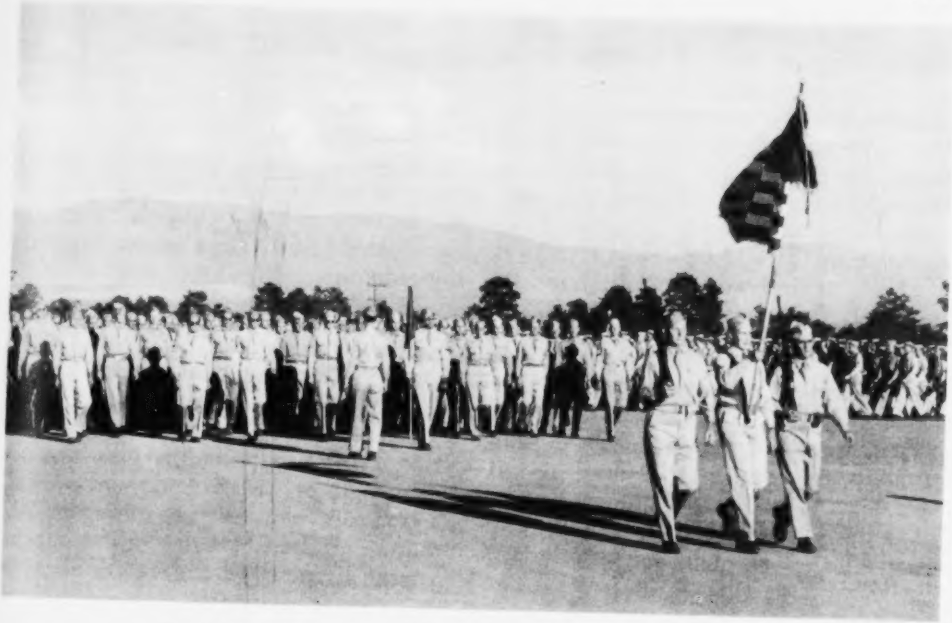
[41] The organization, procurement, and administration of the project's military intelligence and security units are discussed in detail in Ch. XI. MDH, Bk. 1, Vol. 8, pp. 7.6–7.8 and App. A13, DASA.



THE LARGE TROOP CONTINGENT AT LOS ALAMOS ON PARADE

except at Oak Ridge, Richland, Los Alamos, and New York; those at Oak Ridge and in New York lived in government quarters and received a daily monetary allowance in lieu of rations.[42]

In early 1945, the OCE, which had been serving the project as a higher-echelon channel for manpower procurement and organization, provided the Manhattan District with a military designation: 9812th Technical Service Unit, Corps of Engineers, Manhattan District. Effective on 1 February, most of the uniformed personnel, including SED units at Clinton, Hanford, and Los Alamos, were assigned to the 9812th. At Los Alamos, however, military police, WAC, and other service elements continued to be assigned to the 4817th Service Command Unit, an element of the 8th Service Command.[43]

Success in the procurement of tens of thousands of new employees with a variety of skills and talents, perhaps unmatched by any other World War II program, was directly attributable to the personnel policies and organization developed by the Army for the Manhattan Project in late 1942 and 1943. General Groves and the District personnel staff had persevered during the period of severe manpower shortages and—by combining effective use of existing manpower procurement facilities in the OSRD, the War Department, and the War Manpower Commission with those developed for the Manhattan District—were able to meet substantially all of the atomic program's requirements for scientific and technical workers, skilled and unskilled industrial labor, and civil and military personnel on schedule. Consequently, by late 1944, with most of the manpower procurement needs attained, project officials could shift their primary focus to conservation of the work force in face of such potentially eroding factors as the demands of Selective Service and labor union organizing activities.

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[42] Ibid., pp. 7.6–7.10, DASA; Memo, Col Elmer E. Kirkpatrick, Jr. (Dep Dist Engr), to Groves, sub: Mil Personnel at Oak Ridge, 19 Oct 44, Admin Files, Gen Corresp, 319.1 (Rpts), MDR.

[43] MDH, Bk. 1, Vol. 8, p. 7.7, and Bk. 8, Vol. 1, pp. 7.3.–7.8, DASA; Memo, Nelson to Groves (through his assistant, Brig Gen Thomas F. Farrell), 22 May 45, Admin Files, Gen Corresp, 200.3, MDR.

CHAPTER XVII

Manpower Conservation

In a wartime environment of persistent labor shortages and extensive labor turnover on most jobs, the Manhattan Project's problems of maintaining an adequate work force almost matched those of manpower procurement. In fact, for a variety of reasons, the District had to contend with an above-average rate of employee turnover, Selective Service demands, and work stoppages. Fortunately, many of the measures adopted to recruit scarce workers, such as granting special fringe benefits and paying above-average wage rates, also helped retain employees on the job. These did not solve all the manpower-depleting problems, however, and the Army had to undertake a number of special measures to conserve the work force.

Labor Turnover: The Problem and Its Cure

Turnover of construction workers at the Clinton and Hanford sites during the first half of 1944, a period of peak employment of this type of labor, averaged about one-fifth of the total construction work force, a rate considerably above that at comparable wartime projects elsewhere in the United States. The rate was slightly higher at Hanford than at Clinton—some 20 percent as compared with 17 percent. Turnover was less serious among plant-operating employees, but still sufficiently high to constitute a continuing manpower problem. Thus at the period of peak operations during the summer of 1945, the gaseous diffusion plant had an average turnover of about 13 percent a month and the electromagnetic and plutonium production plants each a little over 6 percent a month.[1]

Seeking to reduce excessive labor turnover, Manhattan administrators undertook aggressive countermeasures. As a first step, the District established exit interview offices at its area employment centers near Manhattan installations. Each employee leaving the project—whether voluntarily, for cause, or as a result of reductions-in-force—was encouraged to have an exit interview with District personnel officials. Through this means they were able not only to gain an insight into the nature of the employees' major complaints but also, in many instances, to persuade them to stay on the job.[2]

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[1] MDH, Bk. 1, Vol. 8, "Personnel," p. 3.1 and Apps. A5 (Chart, MD Labor Turnover)–A6 (Graphic Experience of Principal MD Projs in Labor Turnover, Absenteeism, etc.), DASA; Fairchild and Grossman, *Army and Industrial Manpower*, p. 141 (Table 2, Monthly Labor Turnover Rate Per 100 Employees in Aircraft, Munitions, and Nonmunitions Industries: 1943–44).

Ranking high on the employees' list of complaints was their dissatisfaction with employment conditions, including inadequate wages, excessive hours, and lengthy commuting distance to and from the job site. For example, in mid-1944, 13 percent of the construction workers voluntarily leaving jobs at Hanford and 14 percent of those at Clinton cited some aspect of employment conditions as the reason for their departure. Another recurring complaint concerned living conditions, with more workers in 1944 finding these unsatisfactory at Clinton than at Hanford. Surprisingly large numbers of workers also left to take jobs they viewed as better than the ones they had held on the atomic project. That so many workers could do this was indicative of a major underlying problem in maintaining a work force—the fact that for much of the time in 1943 and 1944 there were more jobs available in the areas near the atomic installations than there were qualified workers to fill them.[3]

Analysis of data accumulated in the exit interviews indicated that most project employees were interested primarily in earning the highest hourly wages possible. Accordingly, District manpower authorities took steps to make Manhattan wage rates competitive, if not better, than those on other wartime projects. Working through the War Manpower Commission, the National War Labor Board, and other manpower agencies, they secured significant adjustments in Manhattan wage scales, bringing them up to the pay levels of competing projects. Exit interview data also revealed that project workers did not object to long hours if they received overtime pay for time put in beyond the regular workweek. For example, when Du Pont in the summer of 1943 reduced the workweek on construction jobs at Hanford from fifty-eight to forty-eight hours, eliminating most overtime, workers began leaving at a greatly accelerated rate. Only when General Groves personally intervened, directing Du Pont to extend the workweek to fifty-four hours, did employee turnover decline to an acceptable rate.[4]

The frequency of complaints about living conditions made it evident that new community facilities were needed at Clinton and Hanford. District officials began with a renewed emphasis on securing greater cooperation from the leaders of existing communities adjacent to the sites in the provision of housing, commercial and recreational facilities, transportation, and the other more urgent requirements of project workers temporarily residing in those communities. At the same time, the District made every effort to speed up construction of housing and other facilities in the towns of Oak Ridge and Richland.[5]

While the District could overcome some glaring deficiencies in employment and living conditions, it could not hope to provide the comforts and conveniences available in long-established, thickly populated communities. District officials, however, tried to inculcate great toleration and acceptance among project workers for the unavoidable hardships and inconveniences. This was the goal, for example, of an extensive campaign begun in the summer of 1944 to raise the morale of the work force. Through public media—stories in company newspapers, strategically located billboards and posters, and film trailers shown in local theaters—the District personnel office circulated materials designed to appeal to the workers' sense of patriotism and their pride in contributing to the completion of a difficult job under adverse conditions.[6]

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[2] MDH, Bk. 1, Vol. 8, pp. 3.1–3.2, DASA.

[3] Ibid., App. A5, DASA.

[4] Statement on Requested Increase in Operating Rates at Clinton Engineer Works, attached to covering Memo, 14 Jun 44, HB Files, Fldr 51, MDR; MDH, Bk. 1, Vol. 8, p. 3.3, DASA.

[5] See Chs. XXI and XXII for a more detailed discussion on the development of community facilities and relations.

Despite these countermeasures, absenteeism and labor turnover continued to rise in 1944. After consultation with officials of the War Manpower Commission, District manpower authorities decided to dispatch special investigative teams to Clinton and Hanford. These teams—each comprised of a representative of the Manpower Commission, a labor officer from the Army Service Forces (ASF) headquarters, and an officer from the District staff—conducted thoroughgoing labor surveys of several weeks' duration.[7]

Rather surprisingly, the Clinton team came up with a recommendation that no special efforts be made to solve the turnover problem. They reported that the amount of absenteeism and turnover at Clinton was indeed high; in fact, much higher than at Hanford. Nevertheless, the team members felt that District manpower authorities had progressed so far in developing good labor relations and in providing suitable living conditions and community facilities that the problems with the work force no longer posed a threat to completion of the project. Further confirmation of the optimistic report came from the chief of the Labor Branch of the ASF's Industrial Personnel Division, Lt. Col. John K. Collins. Wishing to consult with the team members on their findings and to assess the situation firsthand, Collins made an inspection visit in mid-May. He concurred that facilities for workers were "uncommonly good," and discovered that the high rate of absenteeism and turnover indicated in the team's statistics was not primarily the result of the construction workers' dissatisfaction with working and living conditions but more directly attributable to the fact that many of them came from nearby farms and periodically had to take time off to do farm work.[8]

While lacking the glowing optimism of the labor survey reports on Clinton, the report from the Hanford team was highly commendatory of efforts made to achieve the best facilities feasible under rugged circumstances. The team considered employment conditions comparable with those on similar heavy construction projects in progress, and pointed out the various ways in which management had endeavored to eliminate the more trying and irritating inconveniences. Chief causes for absenteeism and labor turnover, the team concluded, were rumors that misrepresented conditions at Hanford and the recruitment of many older, inexperienced, and less physically able employees who could not readily adjust to the demands of the work. The team recommended that both the War Manpower Commission and the United States Employment Service could assist in reducing labor turnover by taking steps to curb unsubstantiated rumors and making greater efforts to screen out poor risks among job applicants.[9]

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[6] MDH, Bk. 1, Vol. 8, pp. 3.3–3.4 and App. B8 (Documents Illustrative of Use of Public Media To Curtail Job Turnover and Absenteeism), DASA.

[7] Ibid., Bk. 1, Vol. 8, pp. 3.5, DASA.

[8] Ltr, Maj L. Dale Hill (MD member of labor survey team) to Dist Engr, sub: Labor Survey at CEW, 23 May 44, copy in MDH, Bk. 1, Vol. 8, App. B10, DASA; Memo, Collins to Groves, sub: Visit to CEW (16–17 May 44), 22 May 44, HB Files, Fldr 79 (Jack Madigan), MDR.

As building of the Clinton and Hanford plants neared completion, the project's need for construction workers declined. Concerned about the disrupting effect of large-scale reductions-in-force, the District implemented a policy of recruiting the operating staffs from among employees on the construction work force. Because these jobs were more secure and employment and living conditions had greatly improved, the rate of turnover and absenteeism among plant-operating employees was much less than among construction workers. The District, nevertheless, continued a vigorous program of manpower conservation into the postwar period. The most crucial period of plant operation came in the first half of 1945, and personnel supervisors constantly had to counteract the tendency among employees to relax their efforts as Allied victory over the Axis powers seemed assured.[10]

Special Problems With the Selective Service System

Operation of the Selective Service System created special problems in manpower conservation for the Manhattan Project. Although other major wartime industrial enterprises experienced similar problems, certain factors made Manhattan less able to tolerate losses from its civilian work force to military service. Because of the unique and complex technology involved in many of its operations, the project employed a higher percentage of workers, especially among its scientists and technicians, who had indispensable and often irreplaceable skills. Also, because of the enormous urgency of the bomb development program, the project faced an almost continuous series of construction and production deadlines that could be met only if key employees at all levels could be kept on the job. Finally, because of the highly secret nature of project activities, Army administrators had to exercise great care that compliance with Selective Service regulations did not result in serious breaches of security.[11]

Faced with these unusual problems, the Manhattan District had to develop special measures for dealing with the Selective Service System to prevent an unacceptable erosion of its civilian employees. The civilian force was comprised of those employed by project contractors and civil servants assigned to the District headquarters or area offices. The first category of workers constituted the greater problem in terms of Selective Service policies, because this group far outnumbered their federal counterparts; the second category of workers was subject to the somewhat modified Selective Service regulations that governed all civil service employees in World War II. Because Selective Service regulations generally prohibited group deferments, the Manhattan Project, as did every other wartime employer, dealt with its draft problems in terms of the case of each individual worker and mostly at the level of the local Selective Service Board. From the administrative standpoint, especially that of security, this approach greatly complicated the draft problem for District manpower authorities because it meant they had to negotiate with hundreds of different local boards. And in each case they had to decide whether to permit a particular employee to be inducted into service, to request a delay in his induction until he could be replaced, to seek his temporary or permanent deferment, or to have him inducted and then assigned to a Manhattan military unit, such as the Special Engineer Detachment.[12]

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[9] Rpt, Spec WMC-WD Team Assigned to HEW Proj (prepared by Ned McDonald, WMC, Maj I. B. Cross, Jr., ASF, and Maj R. L. Newcomb, CE), 20 Jun 44, copy in MDH, Bk. 1, Vol. 8, App. B9, DASA.

[10] MDH, Bk. 1, Vol. 8, pp. 3.5–3.6 and Apps. A1, A1.1, A6, DASA.

[11] Selective Service System, *Industrial Deferment*, Special Monograph No. 6, Vol. 1 (Washington, D.C.: Government Printing Office, 1948), pp. 1–2.

Until late in 1943, when major changes occurred in draft regulations, manpower requirements of the Selective Service System did not present a serious threat to the project. Consequently, the District placed a priority on maintaining security, rather than obtaining deferments for its personnel. Instead of setting up a special staff, the District delegated to project contractors the task of resolving the draft problems of their employees and limited its intervention in Selective Service problems to the relatively few cases involving its own government employees. This policy was generally feasible as long as Selective Service regulations exempted a large body of manpower for family dependency. Project contractors hired most of their workers from this group and also could usually secure replacement for those employees who were drafted from this reservoir of manpower. Inevitably, there were some exceptions. For example, uniquely qualified scientists and technicians could not be replaced by members of any exempted class. In these instances, District manpower officials, with strong support from Secretary Stimson, intervened with Selective Service authorities to obtain deferments.[13]

After the Japanese attack on Pearl Harbor and America's entry into the war, the Selective Service had moved steadily toward inducting men from hitherto deferred classes. By late 1943, the need for additional manpower for the armed forces was so critical that the Selective Service informed local boards to consider drafting fathers as of 1 October. Within two months, following passage of congressional legislation extending and ratifying this policy, the atomic project faced the prospect of losing thousands of key employees at the very time when its own manpower needs were reaching a peak. The draft regulations also placed in question the occupational deferments of many younger scientists, technicians, and skilled workers who had no dependents, for public opinion consistently favored selection of younger men without family responsibilities.[14]

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[12] MDH, Bk. 1, Vol. 8, pp. 6.6–6.15, DASA; *Industrial Deferment*, pp. 231–32.

[13] MDH, Bk. 1, Vol. 8, pp. 6.6–6.15, DASA; Selective Service System, *Dependency Deferment*, Special Monograph No. 8 (Washington, D.C.: Government Printing Office, 1947), pp. 33–51; Ltrs, Secy War to Chairman, WD Central Deferment Board, 8 Mar 43, and Secy War to Maj Gen Lewis B. Hershey (Selective Svc System Dir), 1 May 43, Admin Files, Gen Corresp, 231.1, MDR.

To avert the deleterious effects of any manpower losses, the District abandoned its earlier hands-off policy and assumed a more decisive role in draft matters by reorganizing Selective Service functions. In late 1943, control over deferment procedures through the District was centralized at the Oak Ridge headquarters under administration of a newly formed Selective Service Section. In December, the section took over the Selective Service functions of the former Clinton Area Engineers Office. Shortly thereafter, in support of its more active participation in draft matters, the District established branch offices in New York City and Chicago and at the Hanford Engineer Works, where the area engineer subsequently formed a separate section to process deferments for operating personnel in the plutonium facilities. Finally, to assist the District's Selective Service Section in review of draft cases involving project civil service employees, the Secretary of War appointed a regional deferment committee that was comprised of three commissioned officers from the Manhattan District.[15]

Organized and functioning much like a state Selective Service headquarters, the District's Selective Service Section instituted a variety of measures that facilitated the prompt resolution of draft problems. It reviewed each draft case and advised the district engineer on procedures to be followed in its resolution, and also regularly issued to project contractors and area engineers circular letters containing all pertinent Selective Service information allowable within the security requirements of the project. Then in early 1944, under the so-called West Coast Plan that provided for deferment of workers in critical war industries, the section successfully obtained for project contractors at thirteen Manhattan establishments (including the Metallurgical Laboratory, Clinton Laboratories, Hanford Engineer Works, and the Kellex Corporation) authorization to defer those employees essential to maintain construction and production schedules. These measures contributed to the relief of state Selective Service directors from personal responsibility for Manhattan District deferments granted earlier—deferments that, under the pressure of manpower shortages in 1944, state directors, not really understanding why atomic project workers were essential, were more and more prone to question.[16]

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[14] MDH, Bk. 1, Vol. 8, pp. 6.6–6.11, DASA; *Dependency Deferment*, pp. 53–58.

[15] Org Charts, U.S. Engrs Office, MD, 1 Jun, 28 Aug, 10 Nov 44 and 26 Jan 45, Admin Files, Gen Corresp, 020 (MED-Org), MDR; MDH, Bk. 1, Vol. 8, pp. 6.15–6.17, and Bk. 4, Vol. 5, "Construction," pp. 4.18–4.19, DASA; *Industrial Deferment*, pp. 243–45.

[16] MDH, Bk. 1, Vol. 8, pp. 6.6–6.11 and Apps. A9–A11, DASA; *Industrial Deferment*, pp. 112–13 and 166–69.

A new threat to project manpower needs arose in January, when the Selective Service began enforcing a more stringent policy on occupational deferments for younger men (generally under age thirty). Administrators at Los Alamos, for example, predicted that such a policy would be disastrous for the entire project. Wasting no time, the District's Selective Service Section began providing local draft boards with detailed data on the educational background, work experience, and contributions to the project of thousands of its younger employees. At the same time, it also urged project contractors to actively support continued deferment of workers classified as disqualified for military service (4–F) or for limited service (LA–1). By the time the war ended, the District had approved and forwarded to the Selective Service System more than thirty-eight thousand original deferment cases and renewed more than ten thousand of these cases. In addition, area engineers had directly processed thousands more.[17]

In the period after the war, some critics asserted that the Selective Service System had "greatly crippled" the atomic project. Manhattan administrators disagreed, however. According to Colonel Nichols, for example, in the approximately sixty thousand deferment actions handled up through June 1946, "no one has been lost to the project whose services were essential."[18] Certain Selective Service measures had threatened key project operations, but the District's effective policy of energetic counteraction had enabled Manhattan officials to avert any serious interference with the progress of the bomb development program.

Labor Relations: Union Activities and Work Stoppages

Employer-employee relations was an important factor in the conservation of the Manhattan Project work force.[19] Given the industrial character of its activities, these relations naturally centered on questions of unionization and unions. But unusually stringent security requirements greatly circumscribed the extent to which normal labor activities could be pursued. Nevertheless, consistent with the War Department policy established in the early months of the war, the Army permitted workers on the atomic project to carry on union activities as long as they did not interfere with achievement of the major objectives of the program. This policy excluded, of course, resorting to strikes and any other labor activities that would interrupt war production or compromise security.

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[17] MDH, Bk. 1, Vol. 8, pp. 6.11–6.13 and App. A12, DASA; Ltrs, Arthur L. Hughes (Personnel Dir, Los Alamos Lab) to Samuel T. Arnold (MD Consultant for Tech Personnel), 15 Jan 44, and Oppenheimer to Groves, 8 Apr 44, Admin Files, Gen Corresp, 201 (Gen), MDR. See also Memo, unsigned (probably Groves), ca. Apr 44, HB Files, Fldr 105, MDR.

[18] Statement by Nichols, 7 Jun 46, Admin Files, Gen Corresp, 201 (Gen), MDR.

[19] Section based on MDH, Bk. 1, Vol. 8, pp. 4.1–4.14 and Apps. A2 (Table, Manhattan Proj Contractors' Employment, Aug 42–Dec 45) and A7 (Table, Analysis of Work Stoppages–Constr Contractors); Bk. 4, Vol. 6, "Operations," p. 13.3; Bk. 8, Vol. 1, "General," p. 6.62. All in DASA. Fairchild and Grossman, *Army and Industrial Manpower*, pp. 72 and 129–30. Rpt, John H. Ohly, sub: Formulation of Labor Policies To Govern Opn of CEW, 10 Nov 44; Memo, Ohly to Brig Gen Edwin S. Greenbaum (Und Secy War's labor adviser), ca. 11 Nov 44; Memos for File, Ohly, sub: MD, 13, 18, and 21 Dec 44; Ltr, A. C. Joy (Act Dir, Tenth Region, NLRB, Atlanta, Ga.) to Und Secy War, sub: Roane-Anderson Co., Case 10–R–1369, 28 Nov 44. All in HB Files, Fldr 80, MDR. Memos, Und Secy War to Byrnes, 27 and 30 Nov 44, HB Files, Fldr 51, MDR. Marsden Diary, 29 Nov 44, OROO.

To deal with Manhattan Project labor relations problems, the Army relied extensively on experience gained, starting with the period of emergency preparedness in 1940–41, as an employer of thousands of workers in arsenals and depots and on Corps of Engineers construction projects and as administrators of government-owned, contractor-operated (GOCO) plants that produced munitions of war. From this experience the Army learned that the most efficient means for recruiting workers was through those unions affiliated with the Building and Construction Trades Department of the American Federation of Labor (AFL). This method minimized union-organizing and -recruiting activities on the job, because the Army and the AFL had agreed that contractors must maintain a closed-shop policy.

In the event that unions would be unable to satisfy Manhattan's quotas for skilled and unskilled workers, the Army-AFL agreement permitted contractors to procure them elsewhere, with the provision that they join the appropriate union before starting their employment. When the AFL laborers union could supply only a fraction of the quota needed at the Clinton Engineer Works, the contractors—working with District manpower authorities—turned to the War Manpower Commission and federal employment agencies for recruitment assistance. Recruitment of workers through government channels, however, obviated compliance with the existing policy of union membership. To have required it, General Groves pointed out to District personnel monitoring labor problems, would mean, in effect, that the government was subsidizing recruitment for a labor organization.

The District's efforts to minimize those union activities likely to impact negatively on construction and production schedules, as well as pose a threat to security, generally were effective. But work stoppages—for the most part, of very brief duration—did occur. The largest number resulted from jurisdictional disputes between crafts. In April 1943, for example, when electricians and ironworkers at Clinton disagreed over the handling of heavy electrical equipment, they walked off the job. The walkout lasted two days, during which 522 man-hours were lost. Some work stoppages occurred over discharge or transfer of employees. Typical was a case in February 1944, when members of the welders union at Hanford struck briefly to protest transfer of one of their members to the night shift, allegedly because of a grudge between the area superintendent and the employee. Time lost totaled 171 man-hours.

Dissatisfaction with wage rates and employment conditions caused a few work stoppages. Plumbers at Clinton walked off the job briefly in December 1943 in protest against a rule requiring that they use a parking lot more than half a mile from the point where they punched their timecards, and millwrights engaged in construction of a plant for the atomic project at Decatur, Illinois, ceased work for a few hours in August 1944 in dispute over payment of shift time. In one or two instances where a large number of key construction employees were involved (for example, electricians at Clinton in December 1944), the loss of man-hours was considerable (in this case some forty thousand hours). But quick settlement of most disputes averted any disastrous slowdown in the building program.

The District faced far more novel and complex labor relations problems in administering the project's operating employees. Many operating employees had to be made privy to highly classified data and equipment, whereas most construction employees had no need for secret information. Typically, too, the atomic project's unique operating processes were far more vulnerable, and labor activity that interfered with operations simply could not be tolerated. Furthermore, most operating employees were not union members and their work did not fit nicely into any of the usual job categories.

Most of the commercial and industrial firms and the research institutions that accepted operating contracts with the atomic project customarily adhered to an open-shop policy. Du Pont, with major operational responsibilities at various project installations, had never been unionized in its private commercial operations. The same was true of the Tennessee Eastman Corporation, operator of the electromagnetic plant at Clinton. Similarly, most of the university contractors were nonunion employers. There were a few exceptions. The University of Chicago had a written agreement with the State, County, and Municipal Workers of America, a CIO (Congress of Industrial Organizations) union, but it had little effect on employee relations at the Metallurgical Laboratory. The University of California recognized the right of the Alameda County Building Trades Council unions to establish pay rates and conditions of employment for all maintenance employees hired by the university.

There were exceptions, too, among the commercial and industrial contractors. The primary business of the community service contractors (Robert E. McKee at Los Alamos, the Morrison-Knudsen Company in the Hanford area, and the Oak Ridge–based Roane-Anderson Company, a subsidiary of the Turner Construction Company of New York) was construction work. They were accustomed to dealing with the construction unions and found that they could secure most of the employees needed for community operation and maintenance through the AFL Building Trades unions. A number of the operators of smaller project plants also normally employed union labor and continued to do so in carrying out their Manhattan contracts. The Houdaille-Hershey Corporation of Decatur, Illinois, for example, which made barrier material for the gaseous diffusion process, signed an agreement with the Building Trades unions. Also, many of the firms manufacturing equipment and materials for Manhattan—such as the Allis-Chalmers Manufacturing Company, Chrysler Corporation, and Hooker Electrochemical Company—already were unionized.

For reasons of security, District manpower authorities frequently had to substitute for government and union officials in carrying on labor relations with nonunion operating employees. In cases of alleged violations of the Fair Labor Standards Act and the Walsh-Healey Act and in the conduct of inquiries made by the Fair Employment Practices Committee, they served in lieu of government representatives; in the few instances when operating employee elections were necessary, they supervised the balloting; and when federal agencies took the initiative in requesting an investigation of employees or when national labor unions sought to hold elections, they endeavored to persuade the agencies or unions to waive the security-threatening procedure and, failing in this, to let Manhattan carry out whatever procedure was deemed necessary.

Several unions pressed District manpower authorities for recognition as bargaining agents for plant-operating employees at the major production sites. To mediate the issue, each union filed a petition with the National Labor Relations Board and requested a formal hearing. The International Brotherhood of Firemen and Oilers filed the first petition in August 1944, seeking to represent the Carbide and Carbon Chemicals Corporation employees who worked at the gaseous diffusion power plant, and subsequently the International Brotherhood of Electrical Workers joined with the Firemen and Oilers union in its petition. When the National Labor Relations Board scheduled a hearing for 24 October, District authorities promptly intervened to prevent a serious security threat. They negotiated with board officials, who, in the end, agreed to postpone the hearing. The postponement, however, was only a temporary victory for the District, as the mediators indicated an ultimate hearing on the petition was mandatory.

General Groves, determined to find a permanent solution to the labor problems of plant-operating employees, turned to War Department labor experts for advice and assistance. As Groves saw it, the atomic program had to achieve three objectives: It had to maintain production schedules; its operations had to be protected from sabotage and subversive interference and from disclosure of information useful to a foreign power; and it had to maintain maximum efficiency and economy. The Manhattan commander felt strongly that District labor policies must be formulated to further these objectives, which, he frankly stated, might best be achieved by forbidding unions among plant-operating employees who worked in restricted areas. This policy, as he visualized it, would mean exclusion of all outside agencies (including the National Labor Relations and the National War Labor Boards) and a ban on all types of union activities. Groves immediately granted, however, that so restrictive a labor policy was probably not feasible and the District undoubtedly would have to be satisfied with a compromise arrangement. He suggested a policy that would permit unions, limiting membership in them to employees of those contractors who had signed a secrecy agreement, would forbid outside union representatives, and would require Army inspection and control of all union activities. If disputes should arise that could not be settled in negotiations between the contractor and the union, they would have to be submitted to the Secretary of War for arbitration.

War Department labor officials were in agreement with General Groves that there was no feasible way for the Army to deny to the project's plant-operating employees all rights to organize. Their views were summarized in a report prepared in November 1944 by John H. Ohly of the ASF's Industrial Personnel Division. After conferring with Groves and several other District representatives, Ohly concluded that labor problems at Clinton were similar to those of the Army's GOCO plants, but there were significant differences: the overall urgency of the atomic project, its employment of several major contractors at one site, its unusually strict security requirements, the sensitivity of its processes to stoppage, and the exceptionally large percentage of its workers residing within a military reservation. Yet these differences, Ohly reported, did not justify denying plant-operating employees the right to organize. "The right to join or associate with others in establishing a union of his own choosing without interference from his employer," Ohly noted, was a basic right possessed by the American working man, and the War Department consistently had adhered to the policy of permitting employees in war industries to continue to exercise that right to the maximum extent practicable under wartime conditions.[20] The extent to which workers at the Clinton plant would try to organize, Ohly believed, depended largely on the attitude of the national union leaders—William Green, Philip Murray, John L. Lewis, and their chief subordinates—toward these efforts. If these leaders should encourage unionization of the atomic plants, Ohly was confident that this labor activity could be accommodated without unduly imperiling the major objectives of the project.

General Groves was willing to go along with the view that production workers should be permitted some organizing activities, but he opposed admission of outside union representatives to project areas and the conduct of public hearings on petitions by labor board officials. He did not succeed, however, in the time gained through several postponements of the union hearings, in attaining an agreement for withdrawal of the petition. Finally, on 24 November, representatives of the National Labor Relations Board notified the District that under the law they must act on the petition and thus scheduled a hearing for 19 December. The Manhattan commander immediately wrote to Under Secretary of War Robert P. Patterson: "We can no longer merely delay action by NLRB. A definite position must now be taken. If the cooperation of the unions could be secured, the problem would be solved. . . . In view of the nature and importance of the project, it is not too much to ask them in furtherance of the national interest to refrain from unionizing the Clinton Engineer Works for the duration. This is the only feasible approach to the problem. No rights are denied and no security is sacrificed." [21]

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[20] Rpt, Ohly, sub: Formulation of Labor Policies To Govern Opn of CEW, 10 Nov 44, MDR.

Groves had expressed his views to Patterson in the course of responding favorably to the Under Secretary's proposal that Manhattan should seek the assistance of James F. Byrnes, director of the Office of War Mobilization, in securing the cooperation of the unions. When Byrnes assented to applying his well-known persuasive powers to securing an understanding with the Electrical Workers and Firemen and Oilers unions, Patterson made the necessary arrangements for a meeting on 5 December. To ensure the support of the major operating contractors at Clinton for any agreement reached at this meeting, Groves, Nichols, and Lt. (jg.) John J. Flaherty, a Navy officer serving as special assistant for labor matters on the district engineer's staff, conferred in New York on 30 November with representatives of Carbide and Carbon, Tennessee Eastman, and the Fercleve Corporation.

The meeting on 5 December in Byrnes's office at the White House laid the groundwork for the eventual establishment of a satisfactory policy governing labor activities of operating employees at the Clinton Engineer Works—and, by extension, to those working at the other major atomic installations—for the duration of the war. With Byrnes's assistance, Groves, Patterson, and Edward McGrady, the Under Secretary's labor adviser obtained a tentative agreement from A. L. Wegener, head of the Electrical Workers, and Joseph P. Clark, who served in a similar capacity for the Firemen and Oilers, to postpone indefinitely the labor hearings with the proviso that the two unions be permitted to represent their membership in the handling of any grievances that might arise. In the days immediately after the White House meeting, the Firemen and Oilers and the Electrical Workers unions confirmed this agreement, as did the International Association of Machinists, which had petitioned for bargaining rights on 28 November with Roane-Anderson.

The Machinists union also filed a petition to organize the thousands of workers employed by Tennessee Eastman in the electromagnetic plant at Clinton, but held it in abeyance in keeping with the agreement. Some local labor leaders, particularly those in the Electrical Workers union, were reluctant to forego organizing activities, for they were convinced that the operating contractors simply had used the Army to push through the ban on union organization which they desired. Only through the combined efforts of War Department–District labor officials and national union representatives were the skeptical local labor leaders finally persuaded to give the District's alternative grievance procedures a chance to be tested before renewing their organizational activities.

The procedures adopted for hearing grievances were patterned on those used in GOCO plants. In September 1944, the district engineer directed that all operating contractors at Clinton institute their own grievance procedures, requiring only that the latter conform to general standards laid down by District manpower authorities. These procedures guaranteed each operating employee equal access to "a fair and complete review of his grievance."[22] They also ensured him a hearing without delay and resolution of his case within thirty days. The employee could take his grievance through the various levels of plant supervision—foreman, superintendent, and so forth—up to a final hearing by a representative of the district engineer. In this final review, the aggrieved worker could be represented by a union steward, who, for reasons of security, must be an employee of the same contractor as the worker.

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[21] Memo, Groves to Und Secy War, 28 Nov 44, Incl to Memo, Und Secy War to Byrnes, 30 Nov 44, HB Files, Fldr 51, MDR.

The question of unions and union activities among operating employees at the other two major atomic installations—Hanford and Los Alamos—never became a serious problem. Workers at Hanford, many of them already members of construction unions, briefly attempted to organize operating employees in the production plants administered by Du Pont. But Lt. Col. Franklin T. Matthias, the area engineer, promptly intervened. Similarly, outside unions requested permission to organize Hanford workers, but agreed to postpone their effort as long as it would constitute a threat to security. Occasionally individual AFL members in the plutonium production plants endeavored to recruit members, but achieved little success.

Most operating workers at Los Alamos were either civil service or contractor employees, some of whom belonged to unions. By late 1944, there were indications that union members generally opposed employment of nonunion workers in civil service positions. In November, a representative from the Office of the Chief of Engineers in Washington, D.C., meeting in Santa Fe with the director of the Thirteenth U.S. Civil Service Region (which now included New Mexico) and local labor leaders, stated that there would be no discrimination between union and nonunion members in the hiring of civil service employees for Los Alamos. In the case of union workers employed at Los Alamos by project contractors, no labor relations problems of consequence occurred during the period of the war.

The modifications required by the Army in the normal labor activities of Manhattan's operating employees proved to be both workable and effective. In the period of maximum plant operations from late 1944 until September 1945, there was no compromise of security or interruption of production schedules that could be charged to labor activities among operating employees. Furthermore, most production workers came to accept the limitations on their employee rights as being necessary under the circumstances. Consequently, these limitations did not seriously affect employee morale or result in large-scale defections from the job. Perhaps the most concrete evidence of the effectiveness of the project's labor policies was the almost complete absence of work stoppages from late 1944 to the end of the war. Among the tens of thousands of operating employees at Clinton in this period, there was only one instance of stoppage—a brief walkout of general repairmen in May 1945 at the Carbide and Carbon installations. Work stoppages of somewhat greater length did occur at several plants producing essential materials for the project in Detroit, in Decatur (Illinois), and in Uravan (Colorado), but none caused serious interference with production schedules. Even in the immediate postwar period, when restraints on union activities inevitably were weakened, work stoppages traceable to employee organizations or grievances were remarkably low. As of the end of December 1946, when the Army was preparing to turn over control of the atomic project to the Atomic Energy Commission, Manhattan production plants had lost only about eighty-six thousand man-hours, or about 0.028 percent of their potential working time, as a result of work stoppages.

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[22] Ltr, Dist Engr to All Operating Contractors, CEW, 27 Sep 44, copy in MDH, Bk. 1, Vol. 8, App. B11, DASA.

From 1943 through early 1945, the Manhattan Project faced relentless construction and production schedules that could only be met if the adequacy and efficiency of its large and heterogeneous work force could be maintained. Consequently, the military and civilian leaders of the project early realized that they must take strong countermeasures against such prevalent manpower-eroding tendencies in the American wartime environment as high labor turnover, the demands of military conscription, and labor union activities. Making use of many of the same War Department and other governmental channels earlier employed for procuring workers for the project, General Groves, the Manhattan District's manpower staff at Oak Ridge, and the area engineers at the field installations were able to secure approval for such labor turnover antidotes as higher wages and improved housing, to work out special arrangements for retaining critically needed workers with the Selective Service System, and to obtain the cooperation of American union leaders in postponing labor activities that would have jeopardized the production goals and security of the project.

CHAPTER XVIII

Electric Power

Reasonable access to the essential process support elements of electric power, water, communications, and transportation was—as the safety and security of geographic isolation—a critical factor in Manhattan's selection of suitable sites. Attainment of both of these desired features was a difficult challenge, for often they were not compatible with each other. Yet without compromising project requirements, the Army resolved the dilemma by choosing sites that were in comparatively isolated regions of Tennessee, Washington State, and New Mexico and by developing those process support resources available in neighboring and adjacent areas.

Overseeing process support development, particularly when the nation was experiencing a chronic shortage of electric generators, boilers, copper wire, water pipes, and other equipment and materials, became one of the most important activities undertaken by the Army in administering the Manhattan Project. Illustrative of this fact was that Army personnel at every level participated in some aspect of these activities: General Groves and the Washington Liaison Office coordinated with appropriate Washington agencies to secure essential procurement priorities; the district engineer and area engineers supervised process support activities at field installations and major procurement centers; and the Army Engineers and the Signal and Transportation Corps contributed substantially in their respective fields of expertise. And while the problems were most pressing in the early months of site development, Army personnel from the project and other War Department agencies continued to be involved in their solution on a lesser scale throughout the war.

Power Requirements and Sources

Of all the aspects of process support required for the atomic project, none was more vital than electric power. Electricity constituted, so to speak, the very lifeblood of almost every important production process, as well as of many other project activities. In planning and developing the project's electric power program, the Army faced three basic problems. The first was how to procure large amounts of electricity from a wartime economy that was only beginning to overcome chronic shortages. Project leaders initially had estimated a need for approximately 150,000 kilowatts, but the decision to relocate the plutonium production facilities at a separate site had upped the requirement to more than a quarter of a million kilowatts, an amount of electricity that at the time would have met the needs of a typical American city with a population of half a million. As large as these early estimates of power requirements for the project were, time would prove them to have been far too low.[1]

A second problem was to ensure electric service that would never be interrupted. This requirement for virtually unparalleled transmission reliability arose from the peculiarly hazardous character of the industrial processes. Only continuous operation of pumps, fans, and refrigeration equipment would dissipate heat and remove radioactive gases adequately. Also, in the electromagnetic and diffusion processes, almost any interruption in the progressive purification stages would play havoc with closely coordinated production schedules.[2]

The third problem was a matter of security, and related not to supply but to distribution of electric power. Because the quantity of power required could not be produced by generating plants located within the confines of the atomic reservations, much of it had to be brought over extended transmission lines running through areas beyond the reach of effective security protection. Project engineers, therefore, had to devise special techniques that would thwart the efforts of potential saboteurs.[3]

During the early period of project development, Manhattan's administrative and engineering staffs devoted considerable attention to procuring electric power for the proposed atomic installations, especially for the site(s) that would house the major production plants. Preliminary site investigations in Tennessee and later in Washington State occasioned talks with the Tennessee Valley Authority (TVA) and the Bonneville Power Administration (BPA). The objective of these talks was to obtain assurances from the power agencies that sufficient power would be available when needed, or could be developed from new generating facilities under construction.[4] The Army succeeded in

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[1] Marshall Diary, 25 Jun 42, OCG Files, Gen Corresp, Groves Files, Misc Recs Sec, behind Fldr 5, MDR; Ltr, Groves to Herbert S. Marks (Act Dir, Power Div, WPB), 7 Feb 43, Admin Files, Gen Corresp, 675, MDR; MDH, Bk. 1, Vol. 12, "Clinton Engineer Works," p. 12.2 and App. C7, and Bk. 4, Vol. 3, "Design," p. 7.1, and Vol. 6, "Operations," p. 2.17, DASA; Memos, Brig Gen Thomas F. Farrell (Groves's Dep) to Groves, sub: Power Requirements, 5 Jun 45, and Carl H. Giroux (OCE power expert) to Farrell, sub: Power Requirements for CEW, 8 Jun 45, Admin Files, Gen Corresp, 675 (CEW), MDR. A watt, as used in this context, is a unit of power equal to the rate of work represented by a current of one ampere (one coulomb per second) under a pressure of one volt. Thus, project leaders in 1942 were predicting that 150 million watts of power would have to be available on a constant basis to fulfill the operating needs of the atomic production plants.

[2] Memo, Lt Col James C. Stowers (New York Area Engr) to Marshall, sub: K–25 Proj Requirements, 21 Jan 43, Admin Files, Gen Corresp, 600.12 (Projs and Prgms: K–25), MDR; Ltr, Percival C. Keith (Kellex Corp. chief) to Stowers, sub: K–25 Proj Power Supply and Requirements, 25 Mar 43, Admin Files, Gen Corresp, 675 (CEW), MDR; MDH, Bk. 4, Vol. 3, pp. 5.1 and 7.1, DASA.

[3] Ltrs, Groves to J. A. Krug (OWU Dir), sub: MD, CEW, 2 and 30 Jun 43, Admin Files, Gen Corresp, 675 (CEW), MDR; MDH, Bk. 4, Vol. 3, pp. 7.1–7.3, DASA; Memo, WPB (by Joseph Whelan, Rec Secy) to BPA, sub: Power Svc for WD, HEW, 11 May 44, Admin Files, Gen Corresp, 675, MDR; Groves, *Now It Can Be Told*, p. 112.

[4] The TVA, which in 1942 had twelve new dams and a large coal-steam power plant under construction, anticipated raising its capacity from approximately 1.4 to over 2.5 million kilowatts by mid-

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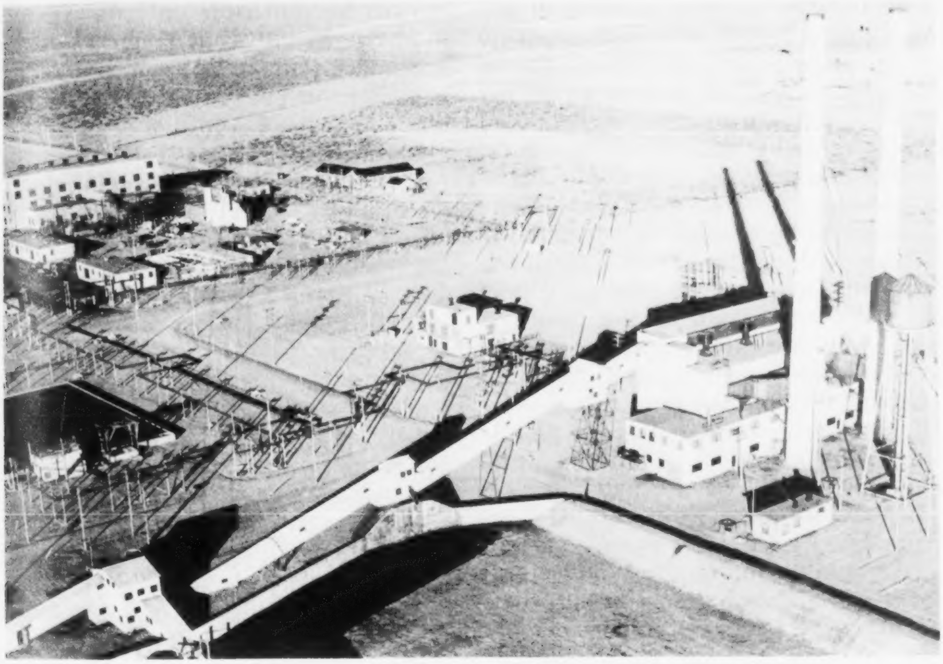

POWER PLANT *(foreground)* AT HEW, *one of several facilities providing steam and backup electricity for the production piles and separation plants*

getting these assurances, but at best they were tentative and did not in any sense constitute a firm guarantee to deliver power to a specified point on a given date. In fact, at the time neither the TVA nor BPA had an appreciable amount of surplus power. Most of their output was committed to war industries, particularly producers of aluminum, and to the many communities located in their service areas.[5]

1945—an increase more than adequate to meet requirements at Clinton. The BPA anticipated generating some 800,000 kilowatts at the new Grand Coulee Dam by mid-1944, in addition to the 86,000 kilowatts it was producing at the Bonneville Dam. See Tennessee Valley Authority, *Annual Report of the Tennessee Valley Authority for Fiscal Year Ending 30 June 42* (Washington, D.C.: Government Printing Office, 1946), pp. 8 and 19–23; ibid., *Annual Report of the Tennessee Valley Authority for Fiscal Year Ending 30 June 45* (Washington, D.C.: Government Printing Office, 1945), p. 58; U.S. Department of Interior, Bonneville Power Administration, *Report on Columbia River Power System, Fiscal Year 1945* (Washington, D.C.: Government Printing Office, 1945), p. 8. The BPA report actually covers operations from 1 Jul 38 to 30 Jun 45.

[5] Marshall Diary, 21 Sep 42, MDR. Background information on TVA and BPA activities may be found in the following sources: Roscoe C. Martin, ed., *TVA: The First Twenty Years* (Knoxville: University of Tennessee Press, 1956), p. 86; "Bonneville Dam, Oregon" and "Tennessee Valley Authority," in *The World Almanac and Book of Facts for 1946*, ed. Harry Hansen (New York World Telegram, 1946), pp. 234 and 703–04; U.S. Engineers Office (Portland, Oreg.) and U.S. Department of Interior, Bonneville Power Administration, *The Bonneville Project: Improvement of the Columbia River at Bonneville, Oregon* (Washington, D.C.: Government Printing Office, 1941), p. 3.

Manhattan leaders' early recognition that a very high priority must go to securing firm commitments for an adequate supply of electric power for the atomic production plants led them to seek immediate assistance from several agencies in the War Department, especially the Office of the Under Secretary of War and the Corps of Engineers, that had developed the organization and personnel prerequisite to negotiating priorities and arranging procurement for electric power and scarce electrical equipment in the wartime economy. General Groves, for example, frequently drew extensively upon the vast amount of data on the nation's electrical resources in engineer files, accumulated since 1920 in carrying out a continuous survey for War Department mobilization planning purposes. Groves also borrowed expert personnel from the engineer staff, including Carl H. Giroux, who became chief adviser on power matters for the Manhattan District.[6]

Groves and Capt. Allan C. Johnson of the District's Washington Liaison Office handled most of the many matters that, in the tightly controlled wartime economy, required clearance through the Power Division (later called the Office of War Utilities) of the War Production Board. They also took responsibility for those aspects of the Hanford negotiations with the BPA that required approval from the Department of Interior. Keeping in close touch with Groves and Johnson, District headquarters officials assisted in many aspects of the Clinton negotiations with the TVA, which had its headquarters in Knoxville, conveniently near the Tennessee site.[7]

Because of the tentative nature of earlier TVA power commitments, Groves directed Captain Johnson to visit the War Production Board. Inquiring about the status of these commitments, the board assured Johnson that more than sufficient power would be available at the Tennessee site when needed. These commitments, however, were based on Manhattan's original power assessment for the site, which, by October 1942, project engineers had determined was too low. New electric power projections were calculated, and on the nineteenth Deputy District Engineer Nichols informed Herbert S. Marks, acting director of the Power Division, that a maximum of 75,000 instead of 60,000 kilowatts would be required by midsummer of 1943, increasing to 125,000 kilowatts by October of that year. Upon reviewing the estimated power requirement of 150,000 kilowatts for early 1944, Nichols remarked that this figure was probably too high and suggested the total be reduced to about 130,000 kilowatts. A final concern was if this requirement would absorb the extra power resources the TVA was accumulating for emergency use, but Marks reassured Nichols that all power requirements for Clinton would be met.[8]

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[6] Smith, *The Army and Economic Mobilization*, pp. 95–96. Evidence of the many occasions when Office of the Under Secretary of War and Corps of Engineers personnel were involved in Manhattan Project power negotiations may be found in MDR, Admin Files, Gen Corresp, 675 (CEW).

[7] Donald M. Nelson, *Arsenal of Democracy: The Story of American War Production* (New York: Harcourt, Brace and Co., 1946), p. 365. See also WPB Org Chart in Civilian Production Administration, Bureau of Demobilization, *Industrial Mobilization for War: History of the War Production Board and Predecessor Agencies, 1940–45, Program and Administration*, Vol. 1 (Washington, D.C.: Government Printing Office, 1947), p. 593 (henceforth cited as *History of WPB*).

Yet sweeping changes under way in the War Production Board's policy relating to nonmilitary government construction threatened the TVA's program for expanding its generating facilities. On 20 October, WPB Chairman Donald Nelson directed all federal agencies involved in large-scale building programs to cease nonmilitary construction not directly essential to the war effort. When news of the directive reached Captain Johnson, he conferred at once with Groves, Nichols, and board officials. Meanwhile, General Styer sent word that TVA Chairman David E. Lilienthal already had asked Under Secretary of War Patterson to resolve this dilemma in face of increasing War Department demands for TVA power.

Johnson interpreted these developments to mean that Manhattan should await the outcome of Lilienthal's consultations with Patterson before submitting a protest, thereby avoiding any contretemps. Patterson subsequently intervened with the War Production Board and obtained permission for the TVA to complete one of its largest projects—the Fontana Dam on the Little Tennessee River in western North Carolina—on the grounds that it was essential to the war effort. And to give additional support to the TVA's case for continuing work on the dam, Groves had the Engineers deputy chief inform the agency that the Manhattan District's maximum power requirements would be between 125,000 and 150,000 kilowatts. Bottlenecks removed, direct action assured completion of the major Fontana generating facilities by early 1945, in time to furnish the Clinton installations with the additional power they would need.[9]

The Military Policy Committee's December 1942 decision to shift location of the plutonium production facilities from Tennessee to another site presented project leaders with another major problem in power procurement. Project engineers estimated that the plutonium installations would require approximately 140,000 kilowatts of electricity by early 1944. Although General Groves was aware of this requirement, he had not obtained a preliminary commitment from the War Production Board and the BPA when Hanford was selected as the plutonium site. Groves was apparently relying on ample evidence that major units of the great Grand Coulee Dam hydroelectric plant, which would have an operating capacity of more than 800,000 kilowatts by mid-1944, were nearing completion. He knew from site reports that the BPA's existing Midway Substation was strategically located at the western edge of the area, where project transmission lines could readily tap the BPA system. Also, lines owned by the Pacific Power and Light Company, a privately owned utility that supplied most of the electricity to local communities in the area, crisscrossed the Hanford reservation at several points, providing an immediately available source of power for early construction activities.[10]

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[8] Marshall Diary, 2 Jul, 21 Sep, 19 Oct 42, MDR; Chart, Site X Electric Power Requirements, 24 Oct 42, Admin Files, Gen Corresp, 675 (CEW), MDR.

[9] Ltr, Nelson to Lilienthal, 20 Oct 42, Admin Files, Gen Corresp, 675 (CEW), MDR; *History of WPB*, p. 401; Marshall Diary, 22 Oct 42, MDR; Memo, Lt Col R. H. Tatlow (WD Rep, WPB Facility Review Committee) to Und Secy War, sub: TVA Projs, 22 Oct 42, Admin Files, Gen Corresp, 675 (CEW), MDR; Martin, *TVA: The First Twenty Years*, p. 86; DSM Chronology, 2 Nov 42, Sec. 26, OROO.

As early as mid-January 1943, the War Production Board learned that the Manhattan Project would be seeking a large block of electric power somewhere in the Pacific Coast area, but it did not hear officially from Groves until early February. On the seventh of that month, Groves submitted a brief description of Hanford's anticipated requirements to the Power Division. Beginning in April, he indicated, the plutonium project would need about 10,000 kilowatts for construction purposes. By December, this requirement would grow to 40,000 kilowatts and then rise in regular increments to a maximum load of approximately 140,000 kilowatts in 1944. Meanwhile, Groves noted, preliminary studies were already under way to determine what electrical equipment must be procured for the plutonium plants and their power distribution system.[11]

The War Production Board promptly notified Groves that the BPA could meet Hanford's power requirements from its Midway Substation and stated its general agreement with the preliminary plans for electrical equipment and distribution for the plutonium site. With this confirmation, Groves turned over to Giroux, his power consultant, the detailed task of reserving blocks of power to be available on specified dates. In negotiations with the BPA office in Washington, D.C., Giroux paved the way for a firm agreement on power reservations, which project officials reached in mid-March with the BPA administrator.[12]

Because of the urgent need for speed, Manhattan had to go ahead with preliminary arrangements for power at both Clinton and Hanford on the basis of only a minimum of information concerning precise design and operating characteristics of the production plants. Consequently, as construction and operation processes were developed in greater detail, project engineers frequently had to revise estimated power requirements—usually upward. New surveys conducted at Clinton in March 1943 revealed that total power needs by May 1944 would be about 285,000 kilowatts (electromagnetic plant, 114,000; gaseous diffusion plant, 160,000; plutonium semiworks, 1,200; the town of Oak Ridge and other installations, 9,500), nearly twice the original estimate. Faced with the considerable increase in previously projected requirements, General Groves dispatched Giroux to the War Production Board. Following negotiations with the TVA, the board reported back to Giroux that the TVA could furnish the indicated 285,000 kilowatts of firm power without unduly interfering with its commitments to other users.[13]

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[10] Matthias Diary, 7 Feb 43, OROO; Groves, *Now It Can Be Told*, pp. 74, 89, 207–09; MDH, Bk. 4, Vol. 3, p. 7.1, and Vol. 4, "Land Acquisition, Hanford Engineer Works," pp. 2.11–2.12, DASA; Du Pont Constr Hist, Vol. 1, p. 10, and Vol. 4, pp. 1059–67 and 1072, HOO; Data on BPA in *World Almanac for 1946*, p. 234.

[11] Ltrs, Marks to Groves, 18 Jan 43, and Groves to Marks, 7 Feb 43, Admin Files, Gen Corresp, 675, MDR.

[12] Ltrs, Marks to Groves, 8 Feb 43, and Paul J. Raver (BPA Admin) to Chief of Engrs, Attn.: Giroux, 17 Mar 43, Admin Files, Gen Corresp, 675, MDR.

At about the same time, important new information came from Kellex Corporation designers on plans for the gaseous diffusion (K-25) plant: Total dependence upon outside power resources would not be practicable or safe. The diffusion process required a vast system of motor-driven pumps and blowers and the Kellex studies showed that even the briefest interruption in power supply would cause an unacceptable reduction in productivity. "For many months . . . ," Groves later recalled, "we labored under the belief that if the plant was shut down through power failure or for any other reason—for as much as a fraction of a second—it would take many days, some said seventy, to get back into full operation."[14]

The obvious solution was to provide the gaseous diffusion facility with its own electric generating unit, and Kellex designers advanced a number of reasons for favoring an on-site location for this power source. An on-site plant could be designed to produce the variable-frequency current required for the diffusion process, thus eliminating the need for expensive, complicated, and difficult-to-procure equipment to transform the TVA's fixed-frequency current. And, a power plant on the reservation would be far less exposed to sabotage than the TVA's off-site facilities, especially its extended transmission lines running miles across open country to the Clinton site. Furthermore, there was always the chance that the TVA, with so many wartime industries dependent upon its resources, might not be able to supply uninterrupted power. With these arguments, Kellex officials persuaded project engineers that a steam-electric plant capable of generating the basic power load for the diffusion process should be built immediately adjacent to the main K-25 works. Groves, in particular, was impressed by the highly positive security and engineering advantages of an on-site power plant.[15]

Kellex's persuasive arguments led to the District's decision in mid-April 1943 to build the steam-electric plant and, shortly thereafter, to contract with the prime construction contractor for K-25, the J. A. Jones Construction Company, for its erection. By early summer work was under way on the generating unit, one of the largest of its type to be built up to that time. Its original design called for nine turbogenerators, operating with coal-heated steam from three

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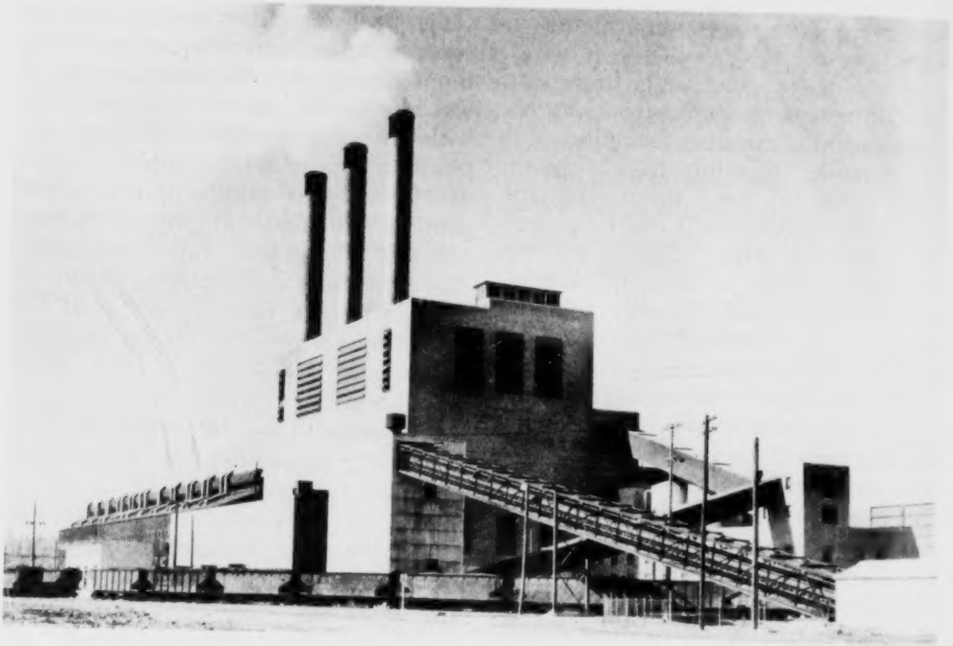
[13] Memo, Lt Col Robert C. Blair (Ex Off, MD) to Marshall, sub: CEW Power Requirements, 30 Mar 43; Draft Ltrs, unsigned to J. E. Moore (Power Prod Br chief, WPB), 30 Mar 43; Memo, Giroux to Groves, 15 Mar 43. All in Admin Files, Gen Corresp, 675 (CEW), MDR.

[14] Groves, *Now It Can Be Told*, p. 112.

[15] MDH, Bk. 2, Vol. 3, "Design," pp. 12.1–12.3, DASA. Memo, Stowers to Marshall, sub: K-25 Proj Requirements, 21 Jan 43, MDR. Ltr, Keith to Stowers, sub: K-25 Proj Power Supply and Requirements, 25 Mar 43; Telecon, Groves and Albert L. Baker (Kellex Chief Engr), sub: Separate Power Plant Instead of Using TVA, 26 Jun 43; Ltr, Groves to Krug, 30 Jun 43. All in Admin Files, Gen Corresp, 675 (CEW), MDR. Groves Diary, 26 Jun 43, LRG. Groves, Notes [in] Black Notebook, OCG Files, Gen Corresp, Groves Files, MDR. The notes are in a small (10" x 7"), loose-leaf, three-ringed binder and were maintained personally by Groves as an aid to memory and as a repository of data on virtually all aspects of atomic project activities from May 1943 through May 1945. Data on power at Clinton are in the section tabbed "Permanent Notes." See also Groves, *Now It Can Be Told*, p. 112.



K-25 Power Plant at CEW

750,000-pound boilers, to produce a maximum of 238,000 kilowatts of variable-frequency power. With this anticipated output, project engineers could reduce estimates of fixed-frequency power needed from the TVA for K-25's "nonvital requirements" to approximately 35,000 kilowatts.[16]

Building a major power plant added substantially to Manhattan's procurement problems during K-25 construction, so District procurement officials frequently turned to the War Production Board's Office of War Utilities for aid in obtaining a variety of scarce equipment. The utilities agency, for example, persuaded a Chicago firm to cancel its order for two already partly fabricated 750,000-pound boilers and also reassigned priorities previously granted to other war projects, thus enabling Manhattan to obtain not only the essential boilers but also eight 25,000-kilowatt turbogenerators. Manhattan subsequently sought a ninth generator to meet peak demands to protect against sabotage, but War Utilities Director J. A. Krug balked at the request, pointing out to Groves that power from outside sources could be brought to the plant over two separate transmission circuits. Each would carry electricity from a different power source, but each would be capable of transmitting the entire power load available in the area. Furthermore, the two TVA circuits were of lightningproof construction and there was a third independent circuit that could be tied in with them if necessary. "Except for *simultaneous sabotage* of all circuits," Krug concluded, "a failure of external power supply is virtually inconceivable. Certainly the combined reliability of several such circuits is incomparably higher than that of a ninth generator unit." [17]

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[16] Dist Engr, Monthly Rpt on DSM Proj, 23 Mar–22 Apr 43, OCG Files, Gen Corresp, MP Files, Fldr 28, Tab A, MDR; Completion Rpt, M. W. Kellogg Co. and Kellex Corp., sub: K-25 Plant, Contract W-7405-eng-23, 31 Oct 45, p. 11, OROO; Telecon, Groves and Baker, sub: Separate Power Plant Instead of Using TVA, 26 Jun 43, MDR; MDH, Bk. 1, Vol. 12, pp. 12.4–12.6, 12.19, 12.23–12.26, and Bk. 2, Vol. 3, pp. 12.1–12.4, DASA. The Admin Files, Gen Corresp, 675 (CEW), MDR, contains a series of progress charts on construction of the K-25 power plant through September 1943. General Groves used the terms *vital* and *nonvital* to distinguish between the kinds of power required for basic plant operation and for other uses on the K-25 project. See Groves Ms, p. 364, CMH.

Krug's arguments failed to budge Groves, who countered with the statements that the gaseous diffusion process simply could not afford to depend upon outside sources for any part of its power and that there would be technical difficulties converting the TVA's current to variable frequency. Groves was willing, however, to consider a compromise solution suggested by Kellex, the substitution of two small turbogenerators capable of producing almost as much current as one large generator. Krug agreed, but the two small units did not suffice and eventually three more turbogenerators were added, bringing the total to fourteen.[18]

While solving the huge electric power requirements of the major production plants at Clinton and Hanford, Manhattan's administrative and engineering staffs also took care of the lesser power needs of the project's research and development installations, including those of Los Alamos. Expanding facilities in Chicago were typical. The Metallurgical and Argonne laboratories required a comparatively small but reliable source of electricity to operate their many research and development projects, and Captain Johnson negotiated with the War Production Board for allocation of adequate power from existing local sources. The Los Alamos Laboratory, because of its geographic isolation, presented different problems. There, the Army post commander assisted project engineers in procuring several small, easily obtainable diesel generators capable of producing the relatively small amount of current required to meet initial needs.[19]

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[17] Ltrs, Krug to Groves, sub: MD, CEW, 11 Jun 43 (source of quote, Krug's italics), and Groves to Krug, same sub, 2 Jun 43; Draft Ltr, unsigned (probably Baker to Stowers), sub: Power Supply Equipment, 30 Mar 43, and appended data. All in Admin Files, Gen Corresp, 675 (CEW), MDR. MDH, Bk. 2, Vol. 3. pp. 12.5–12.6, DASA.

[18] Ltr, Groves to Krug, 30 Jun 43, MDR; MDH, Bk. 2, Vol. 3, pp. 12.6 and 12.20, DASA. In September 1945, a K-25 power plant operator accidentally threw a wrong switch, briefly cutting off the electrical supply. The damage to equipment and loss in production proved much less than had been predicted by Kellex in 1943. For further details on this power outage see Memo, Col Walter J. Williams (K-25 unit chief) to Nichols, sub: Power Failure to Section 2b on 16 Sep, 25 Oct 45; Ltr, Baker to Stowers, sub: Rpt of K-25 Power Failure on 16 Sep, 19 Oct 45, and Incl. Both in Admin Files, Gen Corresp, 675 (CEW), MDR. Groves, *Now It Can Be Told*, pp. 112–13. See Ch. XI for a description of an attempt to sabotage the K-25 supply of electrical current.

[19] Marshall Diary, 27 Oct 42, MDR; MDH, Bk. 3, "The P-9 Project," pp. 3.2, 4.6–4.7, 4.13, 4.19, and Bk. 8, Vol. 1, "General," pp. 5.14–5.15, DASA.

Implementation of the Power Program

Manhattan had largely completed the acquisition phase of its power program by mid-1943. Its next task was to bring these resources to bear upon achievement of basic program objectives through negotiation of complex purchase contracts and operating agreements with the TVA, BPA, and other outside suppliers; through design and construction of distribution systems; and through procurement of materials and equipment.

Manhattan's general purchase contract for power service to Clinton was based on policy agreement that TVA Chairman Lilienthal and Under Secretary of War Patterson had drafted in the fall of 1942. Under terms of this agreement, the TVA would supply all War Department projects at its lowest primary rate, that is, the rate normally granted only to purchases made under long-term contracts; the War Department could terminate any purchase contract on thirty-days' notice without penalty; and, as needed, the TVA would construct additional transmission lines while the War Department would build substations and connecting lines.[20]

The earlier view that War Department purchases would constitute a relatively small part of the TVA's total power production came under close scrutiny in 1944, because power requirements at Clinton had multiplied greatly. Consequently, when Lilienthal prepared to approve Manhattan's power contract in April, he began to have serious qualms about the long-range impact of its future purchases upon the economy of the TVA system. He pointed out to Patterson that if, under the terms of the 1942 agreement, Manhattan should suddenly decide to terminate its purchases of electricity on thirty-days' notice, the TVA would face the prospect of excessive financial loss. Under normal commercial purchase agreements, the TVA protected itself by long-term contracts and higher rates. Lilienthal requested that the War Department provide that "the contemporary record make it clear that the loss, should it occur, is one of the costs of the war and therefore not one that the consumers of electricity in the Tennessee Valley should be singled out to bear." [21]

The Under Secretary of War acknowledged that the TVA was indeed likely to suffer substantial losses should Manhattan elect to exercise the right of thirty-days' cancellation of service and therefore agreed that, if the TVA did not at once find other purchasers for the power it was furnishing the Clinton site, the War Department would support the agency in claiming that such losses were compensable. Manhattan's basic power supply contract for Clinton was signed on 25 April 1944 (effective 1 October 1943), with supplemental provisions for a variety of other electrical services subsequently added. Because the TVA viewed all Clinton activities as being for a single consumer, it billed Manhattan in the same manner as the other large commercial users of power on the TVA system.[22]

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[20] Ltr, Lilienthal to Patterson, 26 Apr 44, HB Files, Fldr 80, MDR.

[21] Ibid.

[22] Ltr, Patterson to Lilienthal, 1 May 44, HB Files, Fldr 80, MDR; MDH, Bk. 1, Vol. 12, pp. 12.1, 12.9,

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The BPA's general purchase contract for power service to Hanford, although agreed upon in February 1944, was not completed in final form until November. The primary cause of delay was General Groves's conviction that the purchase contract did not provide sufficient guarantees for reliable service. Patterson requested the Office of War Utilities to grant additional priorities that would give Hanford first claim on Bonneville power resources under all circumstances and would expedite procurement of materials and equipment needed to make its distribution system more reliable. To establish Hanford's prior claim to power from the Bonneville system, the War Utilities director had his staff prepare a draft priorities directive. This directive, to become effective when the plutonium facilities began actual operations, indicated that the War Production Board had approved all requests for materials and equipment for the BPA-Hanford electrical distribution system to date and that it would continue to do so in the future.[23]

Before giving Hanford prior claim to BPA power, the Office of War Utilities required negotiation of a satisfactory operating agreement. Precise terms, however, were not completed until August 1944, when Manhattan finally forwarded a completed draft to the BPA administrator. The latter took strong objection to certain key provisions, especially those ensuring maximum reliability of electrical service to Hanford. Such provisions, the administrator contended, not only would place unreasonable restrictions on the BPA's generating and transmission facilities, resulting in serious financial losses, but also would prevent the BPA from meeting the full demands of its other customers and from securing new users.

Faced with the prospect of further delay in negotiating a satisfactory agreement with the BPA, General Groves once again turned to Under Secretary of War Patterson. The Manhattan commander explained to Patterson that the BPA administrator's objections were essentially the same as those earlier advanced by Lilienthal concerning the terms of TVA service. On 11 August 1944, acting on behalf of Patterson, Assistant Secretary of War John J. McCloy informed the BPA administrator that if the Bonneville system should incur losses because of "the particular conditions necessarily imposed by the war effort in this instance [service in Hanford], such losses would be one of the costs of the war." [24]

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13 and App. A (Nos. 80, 83–88, 90, 92, 95–96, 209, 211–12, 217), DASA. The original contract provided that Manhattan could not resell current to commercial users, but a 1 Jul 45 supplement granted the project permission to resell limited amounts to concessionaires located within the site boundaries. This supplement also contained a provision that any surplus electricity produced by the K–25 power plant was, if requested, to be made available to the TVA system.

[23] MDH, Bk. 4, Vol. 5, "Construction," p. 7.1 and App. C25, DASA; Du Pont Constr Hist, Vol. 4, p. 1059, HOO. Du Pont Opns Hist, Bk. 3, "Electrical Power Distribution Experience to July 1, 1945," p. 3 HOO. Ltrs, Patterson to Krug, sub: Power Svc for HEW, 22 Feb 44, and Krug to Patterson, same sub, 31 Mar 44; Ltr, Edward Falck (OWU Dir as of Apr 44) to Raver, sub: Power Svc for WD, HEW, 6 May 44; Ltrs, Falck to Patterson, same sub, 11 May 44, and Patterson to Falck, 3 Jul 44, and Incl (Draft Directive). All in HB Files, Fldr 51, MDR. Matthias Diary, 29 Jul 44, OROO.

[24] Quoted words from Ltr, McCloy (for Patterson) to BPA Admin, 11 Aug 44, HB Files, Fldr 51, MDR.

Continued

As soon as the BPA received solid assurances from the War Department that such losses would be covered, it notified the Under Secretary that it would promptly approve the agreement. Under terms of the agreement, the BPA guaranteed Hanford 150,000 kilowatts of electricity and agreed to supervise the remodeling, equipping, maintenance, and repair of the existing transmission system to ensure a stable and uninterrupted flow of power under all predictable conditions. The BPA's approval of the operating agreement cleared the way for the Office of War Utilities to issue the long-delayed priorities directive, thus removing the last obstacle to the development of Hanford's power service.[25]

Implementation of the power resources to meet the relatively modest needs of Manhattan's other installations presented few problems. In most instances, these facilities simply established whatever hookups were required into the already existing transmission systems. No special priorities or operating agreements were necessary as long as the demands of the project did not place an undue burden on the supply of power available. Atomic laboratories on the campuses of universities (for example, at Chicago, California-Berkeley, and Columbia) tapped into available facilities. The heavy water plants at Trail, British Columbia, and at the Army's three munitions installations likewise drew upon existing sources of power.

The situation differed somewhat at Los Alamos, where the nearest high-power transmission line was almost 25 miles distant from the installation site. For more than a year, small diesel-powered generators supplied the bomb laboratory with sufficient electricity. But in August 1944, when power demands increased beyond the maximum load that could be safely generated over an extended period by existing units, project engineers recommended securing additional sources of electricity. Based on their investigation that procurement of an additional generator would take longer and provide less flexibility than constructing a high-voltage line to tie in to the New Mexico Power Company's nearest transmission line, the Army authorized the connecting line. Projected power requirements for 1945, however, surpassed the supply available from the new source. To overcome this shortfall, two more diesel generating units were procured and, in 1946, began providing the additional power needed by the bomb laboratory.[26]

Distribution: Clinton Engineer Works

Both the Clinton and Hanford sites were selected in part because of their location near major power transmission lines, but neither had within its boundaries a well-developed local electrical distribution system. Of the two major sites, Clinton was more deficient in this respect. The thinly pop-

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See also Memo, Groves to Patterson, 11 Aug 44, HB Files, Fldr 80, MDR; Dist Engr, Monthly Rpt on DSM Proj, Sep 44, MDR.

[25] Ltrs, S. E. Schultz (Act BPA Admin) to Patterson, 24 Aug 44, J. J. Gendron (Act BPA Admin) to 11 Oct 44, Patterson to BPA Admin, 17 Oct 44, and Raver to Patterson, 28 Oct 44, HB Files, Fldr 51, MDR; Du Pont Opns Hist, Bk. 3, pp. 3-4, HOO.

[26] MDH, Bk. 8, Vol. 1, "General," pp. 5.14-5.17, DASA.

ulated, largely rural Tennessee countryside had only the low-voltage distribution facilities required to provide local farmers and villagers with modest amounts of electricity. Hence, an immediate task for Manhattan engineers in the fall of 1942 was to plan, design, and build a complex and elaborate system capable of meeting the substantial, highly diversified, and ever-changing power needs for constructing and operating large-scale production plants and their supporting community facilities. Preliminary studies established that such a system required two major types of construction: a net of connecting and tie lines to carry current from the TVA's high-voltage transmission systems, and a number of substations to receive, step down, and distribute the high-voltage electricity.[27]

Getting the electrical distribution system at Clinton built and in operation was a matter of high priority, for site development hinged on a supply of adequate electricity. As soon as Manhattan had assurances from the War Production Board and the TVA that sufficient power would be available, it began negotiating a series of contractual agreements with the TVA. These agreements, most of them completed in early 1943, provided for construction of various transmission line. At the same time, the District assisted Stone and Webster and Du Pont in making arrangements with the TVA to furnish electricity for preliminary construction work via the existing low-voltage transmission system.

To ensure that the system's complex substations would be ready when needed, the District arranged for the construction contractors to build these units. In supplemental contracts negotiated in early 1943, Stone and Webster agreed to build two substations in the electromagnetic (Y-12) plant area that would serve that installation and the Oak Ridge community. Similarly, the A. S. Schulman Electrical Company, working with Kellex on the gaseous diffusion plant, assented to construct the substation that would give that installation access to TVA power.[28]

As 1943 unfolded, the TVA and the construction contractors moved ahead rapidly with the distribution system—a system that would continue to expand and change throughout the war as new demands were made upon it. The availability to Manhattan of the TVA's large staff of experienced electrical engineers and of subcontractors with the necessary equipment and line crews helped to expedite construction. To keep abreast of all developments, the district engineer maintained close supervision over the work through his unit chiefs in charge of construction on Y-12, K-25, and the Oak Ridge community.[29]

The first part of the Clinton electrical distribution net to take shape was the basic transmission line, a 154-kilovolt loop, to supply electricity to the electromagnetic plant and the first section of the town of Oak Ridge. The TVA, under terms of a subcontract with Stone and Webster, designed and built this loop, completing it in June 1943. At a point some distance northeast of the Tennessee site the loop cut into an existing 154-kilovolt TVA line, which carried current generated in hydroelectric plants on the Tennessee River at Norris Dam, northeast of the Clinton site, and Watts Bar Dam, southwest of the site, and ran a distance of 3.6 miles to substation Elza Number 1, built by Stone and Webster adjacent to the electromagnetic plant.[30]

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[27] Ibid., Bk. 1, Vol. 12, pp. 12.9-12.11, DASA; Completion Rpt, Stone and Webster, sub: Clinton Engr Works, Contract W-7401-eng-13, 1946, p. 56, OROO.

[28] MDH, Bk. 1, Vol. 12 pp. 12.1-12.2, 12.9-12.11, 12.19-12.27, DASA.

[29] Org Chart, U.S. Engrs Office, MD, 1 Nov 43, Admin Files, Gen Corresp, 020 (MED-Org), MDR; MDH, Bk. 1, Vol. 12, pp. 12.14-12.27, DASA.

That summer, when electrical service from the TVA's existing rural 12-kilovolt line to the plutonium (X-10) semiworks became unsatisfactory, the TVA, with District authorization, built a new 13.8-kilovolt connecting line. This line, which extended some 6 miles from the switch house at the K-25 power plant to the X-10 area, ensured the comparatively small requirements—never more than 1,000 kilowatts—of the semiworks and its laboratory facilities.[31]

By fall, expansion of the electromagnetic plant and rapid growth of the town of Oak Ridge created a demand for more electricity. To supply additional power, the TVA, again operating under a Stone and Webster subcontract, designed and built a new 154-kilovolt line. Completed in mid-1944, this 14-mile line ran from the TVA's Fort Loudoun Dam generating facilities on the Clinch River south of the site to substation Elza Number 2, built by Stone and Webster at the west end of the extended electromagnetic plant area. It also included a 1.3-mile tie line from Elza 1 to Elza 2, making possible the interchange of power between the two switching points.[32]

The reliability and efficiency of the distribution system was further increased with the addition of a 154-kilovolt line between the electromagnetic plant in the eastern sector of the reservation and the gaseous diffusion facilities in the western sector. The TVA, with District authorization, designed and built this additional transmission line, which ran between Elza 1 and a step-down transformer at the K-25 site. When finished in late 1943, this line not only gave the K-25 area a temporary source of power, pending completion of its own substation, but also furnished the means for satisfying unanticipated power requirements from surpluses available elsewhere in the TVA system.[33]

An increasing demand for TVA power was a corollary to the rapidly expanding atomic production facilities at Clinton, but precisely where it would occur and in what quantities was difficult to predict. This was particularly the case in the gaseous diffusion plant area, where the decision in 1944 to use steam from the K-25 power plant for operating the thermal diffusion (S-50) process and in 1945 to build a side-feed extension (K-27) unit made further tapping of the TVA system mandatory. To compensate for the lower electrical output of the K–25 powerhouse, the TVA agreed to build a 154-kilovolt line from its Fort Loudoun Dam to the K–25 substation, adjacent to the main gaseous diffusion plant, and a supplementary connection from its Norris–Watts Bar line to the newly erected K–27 and existing K–25 substations. A number of other connections were in the planning, but the end of the war obviated their construction.[34]

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[30] MDH, Bk. 1, Vol. 12, pp. 12.13–12.14 and 12.20–12.22, DASA; Completion Rpt, Stone and Webster, sub: CEW, pp. 61–62, OROO.

[31] Completion Rpt, Du Pont, sub: Clinton Engr Works, TNX Area, Contract W-7412-eng-23, 1 Apr 44, pp. 32–33, 36–37, 535, OROO; MDH, Bk. 1, Vol. 12, pp 12.18–12.19, DASA.

[32] Completion Rpt, Stone and Webster, sub: CEW, pp. 61–62, OROO; MDH, Bk. 1, Vol. 12, pp 12.3–12.4 and 12.14–12.15, DASA.

[33] MDH, Bk. 1, Vol. 12, pp. 12.4–12.5 and 12.23–12.26, DASA; Completion Rpt, Kellex Corp., sub: K-25 Plant, p. 12, OROO.

By mid-1945, transmission facilities and power sources at the Tennessee site were capable of providing current at a peak demand rate of 310,000 kilowatts, distributed as follows: Y–12, 200,000; town of Oak Ridge, 23,000; K–25, 80,000; S–50, 6,000; and X–10, 1,000. Actual peak demand during the wartime period never quite reached the maximum figure of 310,000 kilowatts. The highest demand rate recorded was 298,800 kilowatts on 1 September 1945. Peak consumption for any extended period during the war occurred in August 1945, when the electricity used by all facilities for the month totaled about 200 million kilowatt hours.[35]

Distribution: Hanford Engineer Works

As at the Tennessee site, the nucleus of the electrical distribution system for the Hanford site was the existing net of transmission lines and substation facilities, built and operated by local utility firms, including the Pacific Power and Light Company. While awaiting outcome of the prolonged negotiations with the BPA, the Corps of Engineers' Real Estate Branch moved ahead with acquiring these existing facilities. At the same time, Lt. Col. Franklin T. Matthias, the area engineer, and his staff, joined with BPA, Pacific Power, and Du Pont engineers in drawing up plans for the extensive alteration and addition to the existing distribution system, and expediting procurement of materials to carry these out.[36]

Project engineers surveying the existing electrical distribution facilities at the Hanford site found that transmission lines crisscrossed the area at a number of points, constituting a basic power net that could be readily adapted to project requirements. The BPA had built two 115-kilovolt lines through the area that hooked in to the main Bonneville-Coulee twin 230-kilovolt high line at the Midway Substation, located near the western boundary of the site. One of these 115-kilovolt lines extended through site territory east to Hanford village, and thence southeast to Walla Walla, Washington, where it terminated; the other ran generally west from Midway across the western boundary of the site and then northwest to Ellensburg, Washington. Pacific Power's utility lines in the area had been built to serve the small local communities and some individual farms. Its main line, carrying 66 kilovolts, ran north from Pasco through Richland, Hanford, and White Bluffs, thence west to the Priest Rapids Irrigation District's hydroelectric plant on the Columbia River at the northwest corner of the site; this 66-kilovolt line tied into the BPA's 115-kilovolt line at Hanford, thus making it possible for Pacific Power to secure current as needed from the Bonneville system. Short sections of additional 66-kilovolt lines, which provided service to communities in the vicinity of the site, also traversed the project area. To ensure effective control and avoid unnecessary duplication of facilities, Manhattan eventually acquired all of Pacific Power's lines and substations within the site.[37]

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[34] MDH, Bk. 1, Vol. 12, pp. 12.4–12.5, 12.16–12.18, 12.23–12.27, DASA; Dist Engr, Monthly Rpt on DSM Proj, Apr 45, MDR; Completion Rpt, M. W. Kellogg Co. and Kellex Corp., sub: K–27 Extension, 31 Jan 46, pp. 9–10, OROO. See Ch. VIII for a detailed description of the thermal diffusion plant and its demands on the K–25 power plant.

[35] MDH, Bk. 1, Vol. 12, pp. 12.5–12.6 and App. C7, DASA.

[36] Ibid., Bk. 4, Vol. 4, pp. 2.11–2.12, DASA; Matthias Diary, 16–17, 26 and 31 Mar 43, OROO; OCE Basic Data on HEW, Pasco, Wash., 19 May 43, pp. 10–11, Admin Files, Gen Corresp, 601.1 (Hanford), MDR.

While the existing transmission net at Hanford proved to be more than adequate for initial construction activities, it was not capable of bringing the high-voltage loads required for the production plants. For this purpose, BPA engineers designed a 230-kilovolt loop, approximately 52 miles long, that tapped the Bonneville-Coulee lines at the Midway Substation and then ran eastward in a circular configuration that brought it near each pile and separation plant. To ensure complete reliability of service, the BPA built this loop so that current might be fed in from either end and also constructed two additional 230-kilovolt feeder lines to supplement those already running between the Bonneville and Grand Coulee hydroelectric plants. Substations erected in the plant areas reduced the high-voltage current to the levels required for the different plant operations.[38]

The lines acquired from Pacific Power also became an integral part of the Hanford power network. Electricity for the metal fabrication and testing area, the administration area, and Richland village—all located in the southeastern corner of the site—was fed in through the existing BPA 115-kilovolt line from Midway to Hanford, and thence carried southward over the power company's 66-kilovolt Hanford-Pasco line. This latter section was the only part of the company's original system retained as part of the permanent distribution net after Du Pont completed construction. Experienced Pacific Power crews, under subcontract to the Hanford Engineer Works, did much of the construction and modification work on the transmission system.

On 25 February 1944, Du Pont took over complete responsibility for operation and maintenance of all electrical facilities that were not an integral part of the BPA system. The only exception was the Priest Rapids plant, which Pacific Power operated under a separate government contract with technical assistance from Du Pont. This plan was consistent with the Army's stringent security policy of reducing to a minimum the number of firms involved in operational phases of producing fissionable materials. Even though BPA crews continued to maintain and repair its lines in the project area, the area engineer kept them under constant security surveilliance.[39]

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[37] MDH, Bk. 4, Vol. 4, pp. 2.11–2.12 and App. A5 (Map, Transmission Systems at HEW), DASA; Du Pont Constr Hist, Vol. 1, p. 10, and Vol. 4, p. 1059, HOO.

[38] MDH, Bk. 4, Vol. 3, pp. 7.1–7.3, and Vol. 5, p. 7.3, DASA; Matthias Diary, 22 and 27 Jul 43, OROO; Du Pont Constr Hist, Vol. 4, pp. 1059–63, HOO; Groves, *Now It Can Be Told*, p. 89.

In developing Hanford's complex transmission facilities, the BPA and Pacific Power found that procurement of electrical equipment—in particular, wire, generators, and utility poles—was one of their most difficult problems and repeatedly sought assistance from Manhattan. The BPA, for example, had to prepare extensive data to justify its many priorities requests for electrical equipment, and Colonel Matthias assigned an electrical engineer from his staff to the BPA's engineering office in Portland to assist with this task. A typical problem for the Hanford distribution system was procurement of cable for the 230-kilovolt loop in the production plant area. When Manhattan applied for an allotment of scarce copper for this purpose, the War Production Board recommended that it use aluminum cable. Project engineers assented to using aluminum, but then experienced both difficulty and delay in securing the board's sanction for the substitution. As a result, Hanford could not begin procurement of the cable until July 1943. Fortunately, continuing and vigorous expediting efforts by the Army enabled the BPA to complete the loop in time to furnish the electrical energy essential for initial operations of the plutonium production piles in late 1944.[40]

When considered against the background of severe shortages of both electric power and equipment in a wartime economy, securing an adequate supply and distribution of electric power for the atomic installations was a significant achievement for the Manhattan Project and its Army administrators. Their early recognition of the need for firm priorities commitments and skillful use of War Department resources for obtaining them guaranteed Manhattan continuous access to the electric power essential for all of its wartime operations.

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[39] MDH, Bk. 4, Vol. 3, p. 7.3, and Vol. 5, pp. 7.2–7.5, DASA; Du Pont Constr Hist, Vol. 4, pp. 1061–62 and 1065–67, HOO; Ltr, Robins (Act Chief of Engrs) to CG SOS, sub: Acquisition of Land for Gable Proj, Pasco, Wash., 8 Feb 43, Incl to Memo, Col John J. O'Brien (CE Real Estate Br chief) to Lt Col Whitney Ashbridge (CE Mil Constr Br), sub: Land Acquisition in Connection With MD, 17 Apr 43, Admin Files, Gen Corresp, 601 (Santa Fe), MDR; Matthias Diary, 21 and 27 Apr 43, OROO; Memo, G. P. Church (Du Pont's Field Proj Mgr) to T. W. Brown, R. E. Burton et al. (Du Pont and Hanford area office staff members), 17 Apr 43, Incl to Ltr, Matthias to Dist Engr, sub: Proposed Policy for HEW, 23 Apr 43, Admin Files, Gen Corresp, 161 (Du Pont), MDR.

[40] MDH, Bk. 4, Vol. 3, pp. 7.1–7.2, and Vol. 5, p. 7.3, DASA; Matthias Diary, 15 Jun, 19, 22–23 and 28–30 Jul, and 6 Aug 43, OROO; Groves Diary, 29–30 Jun and 1, 7, 9, 12–16, 20 Jul 43, LRG; Du Pont Const Hist, Vol. 4, p. 1062, HOO; Groves, *Now It Can Be Told*, p. 89.

CHAPTER XIX

Communications and Transportation

Along with electric power, communications and transportation constituted vital process support elements for the Manhattan Project's laboratories, production plants, and atomic communities. With the major sites located in widely separated regions of the country, successful project operations were dependent on achieving effective coordination via an efficient communications network and on timely procurement of materials from suppliers in all parts of the United States via readily accessible rail and highway transport. Because preliminary surveys of the Tennessee, Washington State, and New Mexico sites revealed that existing local communications and transportation facilities were relatively rudimentary, the Army—under conditions demanding extraordinary measures of safety and security—faced the large task of developing them into the complex and sophisticated systems required by the atomic installations.

Communications

A common sight in and around the Clinton, Hanford, and Los Alamos installations during their developmental phase was linemen busily stringing and connecting miles of wire or cable, in some instances, across great stretches of mostly open and uninhabited countryside. While much of this was for power transmission, a considerable part was for complex and highly integrated communications systems.

Communications at each of the atomic installations, for all practical purposes, had to be constructed from the ground up, because none of them had more than the minimum facilities normally found in rural, sparsely populated regions in the United States before World War II. Of the three sites, Hanford had the most complete existing system with telephone service being furnished to the towns and farms in the area by five independent companies and the Pacific Telephone and Telegraph Company. Furthermore, the Bonneville Power Administration maintained for its own use a two-way radio network in the vicinity of its 115-kilovolt lines in the Hanford area. In contrast, Clinton had only one telephone line, a 6-mile section of the Clinton-Harriman toll line, that served a few of the farmers who lived in the area and Los Alamos had only a government-owned Forest Service line, operated by the Mountain States Telephone and Telegraph Company and providing service to the boys' school located on the site. With respect to all of the privately owned communications facilities found on the atomic sites, the War Department's policy was to acquire them and, wherever feasible, to integrate them into the extensive systems being planned for Manhattan's atomic installations.[1]

At each of the major sites, Manhattan worked closely with the Army Signal Corps, with local telephone and telegraph companies, and with prime contractor organizations to install the most up-to-date communications available under wartime procurement conditions. Because of unusual safety and security requirements, these communications included such specialized instruments as alarm devices, to warn of fire and other hazardous conditions in time to guarantee evacuation of dangerous areas, and two-way radio networks and radio-monitoring devices. Connections into the nationwide Army Command Administrative Network teletype circuit with codification equipment provided rapid and secure communication between the various facilities of the Manhattan District, including General Groves's personal headquarters in Washington, D.C. Other TWX equipment furnished direct teletype service between prime contractors' field organizations and their home offices. An example was Du Pont's private teletypewriter service between its Hanford and Richland offices and head office in Wilmington.[2]

The Army was more directly concerned with details of designing, building, and operating communications than in most other process support activities, partly because its Signal Corps had the necessary expertise to furnish communications speedily and the Army Command Administrative Network was an established communications system that could serve the specialized needs of the project. Also, the Army wished to maintain close control over all aspects of the project's security system in which all forms of communications played a vital role.

The extent of the Signal Corps' participation in development of atomic project communications varied from site to site. At Clinton, the 4th Service Command signal officer served chiefly in an advisory capacity to the district engineer, participating most actively in the period before the establishment of a communications unit in the Clinton Area Engineers

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[1] MDH, Bk. 1, Vol. 12, "Clinton Engineer Works, Central Facilities," p. 15.1; Bk. 4, Vol. 5, "Construction," pp. 7.7–7.8; and Bk. 8, Vol. 1, "General," pp. 5.23–5.24, DASA. Matthias Diary, 12 Mar and 7 Apr 43, OROO. In Admin Files, Gen Corresp, MDR, see 601.1 (Hanford) for OCE, Basic Data on HEW, 19 May 43, p. 11, and Ltr, Robins (Dep Chief of Engrs) to CG ASF, sub: Acquisition of Land for HEW Proj, 5 Jun 44; and 601 (Santa Fe) for Ltrs, Robins (Act Chief of Engrs) to CG SOS, subs: Acquisition in Fee of Approx 56,200 Acres of Land for Demolition Range Near Kingston, Tenn., 29 Sep 42, and Acquisition of Land for Gable Proj, Pasco, Wash., 8 Feb 43, Incls to Memo, Col John J. O'Brien (CE Real Estate Br chief) to Lt Col Whitney Ashbridge (CE Mil Constr Br), sub: Land Acquisition in Connection With MD, 17 Apr 43.

[2] MDH, Bk. 1, Vol. 12, pp. 15.5–15.6; Bk. 4, Vol. 5, p. 7.8; and Bk. 4, Vol. 6, "Operations," pp. 12.2–12.3, DASA. Matthias Diary, 16 Mar, 7 Apr, 6 May 43, OROO. Du Pont Constr Hist, Vol. 4, pp. 1357–60, HOO.

Office in April 1943. At Los Alamos, the Signal Corps' contribution was limited to furnishing technical advice and some items of equipment. But at Hanford, planning and overseeing construction of the telephone system was one of the largest single jobs undertaken by the Signal Corps in the United States during the war.[3]

In early 1943, after the Signal Corps had agreed to Colonel Marshall's request to assist Manhattan in building the Hanford telephone system, 9th Service Command signal officers participated in a series of planning meetings with representatives of the State of Washington Public Utilities Commission, local telephone companies, Du Pont, and the Hanford Area Engineers Office. A problematic issue was the division of responsibilities for design and construction of the Hanford system: Du Pont and the Signal Corps both wanted the task. Apprised of this situation in June, Groves immediately conferred with officials in the Office of the Chief Signal Officer in Washington, D.C., and, after emphasizing the project's requirement for complete secrecy, successfully worked out an arrangement with them for Du Pont to design the system in conformity with standard specifications of Army telephone installations. According to this working agreement, the Signal Corps' Plant Engineering Agency of Philadelphia would provide Du Pont with its technical expertise, if needed; Pacific Telephone and Telegraph Company crews, under supervision of the 9th Service Command signal officer, would construct the system; both the Signal Corps and area engineer would take responsibility for procuring equipment and materials; and Du Pont would give Pacific Telephone and Telegraph any assistance it needed in handling materials and securing workmen.[4]

The division of responsibilities for design and construction of the Clinton and Hanford communications facilities followed a similar pattern; the prime contractors had responsibility for overseeing the task and the local telephone company for actual construction. At Clinton, Stone and Webster designed the system in consultation with the 4th Service Command signal officer and erected the telephone buildings, but shared the line construction work with the Southern Bell Telephone and Telegraph Company. At Los Alamos, the Mountain States Telephone and Telegraph Company performed whatever construction was necessary.[5]

As Manhattan's production installations reached the operations stage, the Army increased security by tightening up its administrative machinery for control and supervision of communications. At Clinton, for example, the administrative element supervising communications—at first only a unit in the Clinton area office, then later part of a section under the District's executive officer—became in early 1945 a separate branch of the Operations Division at District headquarters in Oak Ridge. Similarly, at Hanford, when the area engineer enlarged his communications staff, he requisitioned Women's Army Corps personnel because they were more readily subject to close security control than civilian employees.[6]

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[3] MDH, Bk. 1, Vol. 12, pp. 15.1, and Bk. 8, Vol. 1, "General," pp. 5.23–5.24, DASA; George Raynor Thompson, Dixie R. Harris, Pauline M. Oakes, and Dulany Terrett, *The Signal Corps: The Test*, United States Army in World War II (Washington, D.C.: Government Printing Office, 1957), pp. 440–41; Matthias Diary, 7, 9, 24 Apr 43, OROO; Du Pont Constr Hist, Vol. 2, pp. 513–15, and Vol. 4, pp. 1067–68, HOO.

[4] MDH, Bk. 4, Vol. 5, pp. 7.5–7.7, DASA; Matthias Diary, 20 May 43, OROO; Du Pont Constr Hist, Vol. 4, pp. 1068–71, HOO; Groves Diary, 10–11 Jun 43, LRG.

[5] MDH, Bk. 1, Vol. 12, pp. 15.1–15.3, and Bk. 8, Vol. 1, pp. 5.23–5.24, DASA; Completion Rpt, Stone and Webster, sub: Clinton Engr Works, Contract W-7401-eng-13, 1946, pp. 63, 68–69, 87–89, 116, OROO.

During the war, however, the Army never actually took over operation of project communications facilities except, of course, those that were used to carry on the business of the District itself and those at Los Alamos, which operated as a military post. Completed installations were turned over to the operating contractors. At Hanford, where Du Pont was both the construction and operations contractor, the company's operational staff continued to hire and supervise employees who manned the switchboards, operated teletype machines, and kept the lines in repair. Similarly, at Clinton, the Roane-Anderson Company assumed responsibility for operating the Oak Ridge community facilities, built by Stone and Webster, and also arranged with the Western Union Company to provide telegraphic service for the town. And the operating contractors took over plant communications facilities in the production areas and employed Southern Bell Telephone and Telegraph Company crews, under supervision of the District's Communications Branch, to do maintenance, repair, and installation work.[7]

Transportation

Transportation problems for the Clinton, Hanford, and Los Alamos sites were similar to those of furnishing electric power and communications. Project site selection teams had chosen locations near well-established railroad lines and highways, but the requirement for relative isolation meant that the sites themselves generally lacked adequate access to these nearby facilities. Clinton's primarily rural acreage had only one major highway and no rail line, although main lines of the Southern Railway and the Louisville and Nashville Railroad ran close by the reservation. Hanford's semiarid farming and ranching country had a highway system adequate only to serve its sparse agricultural population and, in its northern area, a single-tracked, second-class branch rail line. Los Alamos was the most isolated of all, with only a few secondary roads and a branch of the Atchison, Topeka and Santa Fe Railroad some 25 miles distant.[8]

Transportation problems fell into two categories: those within the boundaries of a site, where Manhattan could exercise a great deal of control over their solution; and those within the region immediately surrounding the site, where control was much more tenuous. The Army's objective was to achieve a coordinated system that would adequately serve the transportation needs in both the on- and off-site areas. In the interests of economy, both in time and money, the Army followed a consistent policy of using, to the maximum extent feasible, all available means of transportation and adding new facilities only where project requirements made them absolutely necessary.

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[6] MDH, Bk. 1, Vol. 12, p. 15.1, and Bk. 4, Vol. 5, App. B57, DASA; Org Charts, U.S. Engrs Office, MD, 1 Nov 43 and 26 Jan 45, Admin Files, Gen Corresp, 020 (MED-Org), MDR.

[7] MDH, Bk. 1, Vol. 12, pp. 15.1 and 15.5-15.6; Bk. 4, Vol. 6, p. 12.1; and Bk. 8, Vol. 1, pp. 5.23-5.24, DASA. History of Roane-Anderson Company (henceforth cited as Roane-Anderson Hist), Contract W-7401-eng-115, 30 Nov 51, p. 63 and App. D, OROO.

[8] History of Passenger Transportation at Clinton Engineer Works (henceforth cited as CEW Passenger Trans Hist), Jul 45, pp. 1-2, OROO. OCE, Basic Data on HEW, 19 May 43, pp. 9-12, MDR. MDH, Bk. 1, Vol. 12, pp. 16.1, 17.1-17.2, 18.1; Bk. 4, Vol. 3, "Design," p. 7.4; and Bk. 8, Vol. 1, pp. 2.4-2.6, DASA. Du Pont Constr Hist, Vol. 1, pp. 9-10, HOO.

In those instances where the Army had to provide new transportation facilities, it delegated as much of the task as possible to nonmilitary agencies. Development of transportation means within the boundaries of each site became the responsibility of the construction contractors. At Clinton, the three major construction contractors—Stone and Webster, Du Pont, and the J. A. Jones Construction Company—designed and built the rail and road system, respectively, for the town of Oak Ridge and the electromagnetic plant, for the plutonium semiworks, and for the diffusion plants; at Hanford, Du Pont expanded the existing road network and built an on-site rail system; and at Los Alamos, the M. M. Sundt and A. O. Peabody construction companies, with assistance from post work crews, improved the existing road system and built many road extensions.

To the extent feasible, the Army also assigned transportation as a function of the operating contractors. Roane-Anderson, for example, provided transportation for the town of Oak Ridge, the Tennessee Eastman Corporation for the electromagnetic plant area, the University of Chicago-operated Clinton Laboratories for the plutonium semiworks, and the Carbide and Carbon Chemicals Corporation for the diffusion plants area. At Hanford, Du Pont and the Army shared responsibility for the on-site railroad net, but the area engineer maintained the roads, controlled highway traffic, and operated the bus service within the site. At Los Alamos, where security was an overriding consideration, the Army retained almost exclusive control over operation of all forms of transportation, limiting vehicular traffic within the reservation to trucks, buses, and cars driven by military personnel.[9]

Except for certain aspects that required negotiations with federal agencies, resolution of most transportation problems was the responsibility of the Army officer in charge of each of the sites. He had, for example, to reach agreement with state and local officials on building access roads and improving existing highways, to negotiate with local bus companies to increase service between nearby towns and the site bus depots, to arrange with the Transportation Corps' zone officer for vehicle procurement, and to supervise the construction and operating contractors. Each officer in charge had to set up an appropriate organization within his staff for this particular purpose.

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[9] MDH, Bk. 1, Vol. 12, pp. 16.1–16.21, 17.1–17.7, 18.1, passim; Bk. 4, Vol. 5, pp. 7.8–7.13, and Vol. 6, pp. 8.1–8.3; and Bk. 8, Vol. 1, pp. 5.1–5.3 and 5.13–5.14, DASA. CEW Passenger Trans Hist, p. 1, passim, OROO. Du Pont Constr Hist, Vol. 1, pp. 145–53, HOO.

UNIMPROVED SANTA FE–LOS ALAMOS ROAD

During the period when construction was the dominant activity at Clinton, the district engineer administered day-to-day transportation matters through a section in the Construction Branch of the District's Clinton Engineer Works (CEW) Central Facilities Division. He formed a CEW Transportation Board in December 1943, comprised of representatives of the prime contractors, to assist him in formulating area-wide policies and procedures concerning passenger transport, traffic regulations, licenses and regulatory activities, and government-owned vehicles. In mid-1944, he reorganized the administration of transportation, forming in the Services Branch of the Facilities Division two separate sections—Automotive and Bus Transportation—to monitor automotive, rail and motor freight, and bus operations. At the same time, he transferred the CEW Transportation Board's functions to his policy-making operational group, the Central Facilities Advisory Committee.[10]

At Hanford, the area engineer established in March 1943 a Transportation Department in his office to maintain and operate all transportation except railroads, which Du Pont operated, and to oversee all vehicular procurement—usually surplus stocks from other Corps of Engineers projects or from Transportation

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[10] MDH, Bk. 1, Vol. 12, pp. 18.4–18.5, DASA; CEW Passenger Trans Hist, pp. 9–10, OROO; Org Charts, U.S. Engrs Office, MD, 4 Nov 43, 1 Jun, 28 Aug, and 10 Nov 44, 26 Jan 45, MDR.

Improved Santa Fe–Los Alamos Road, *ascending to the Pajarito Plateau from the Rio Grande valley*

Corps sources. Burgeoning transportation requirements resulted in a departmental reorganization in late 1944, first as the Transportation Office under the chief of operations and finally as the Transportation Branch in the Administrative Division. These requirements gradually declined in early 1945 with the completion of major construction at the site, making possible a substantial reduction of employees in the branch.[11]

Primarily for security reasons, but also consistent with its administration as a military post, the Army furnished and operated almost all types of transportation at Los Alamos. In mid-1943, the post commander assigned responsibility for transportation to a supply and transportation officer in the Supply Division, who, in turn, delegated actual operation of the Motor Pool and Motor Maintenance Section to an assistant transportation officer. This administrative arrangement, with only minor changes, continued for the duration of the war.[12]

Motor Vehicles and Roads

Manhattan's transportation requirements were out of the ordinary, even for a wartime activity. For example, the project was unusually dependent upon the motor vehicle for transporting its employees relatively long distances from the communities where they lived. Primarily for safety and security, major installations at both Hanford and Clinton were not only miles apart but also a considerable distance from their operating communities, Oak Ridge and Richland, and from off-site towns where many other project employees lived. Plant-operating employees residing at Richland had a round trip of from 58 to 76 miles each day. Workers coming from Knoxville by bus rode some 17 to 20 miles to the Oak Ridge terminal and then transferred to other means of transportation to get to specific site locations, including the gaseous diffusion plant nearly 10 miles west of the terminal. Even at Los Alamos, where the need for exceptional security dictated housing as many employees as possible on the site, hundreds of construction and service personnel commuted long distances from off-site communities. Typical was the 35- to 45-mile trip from Santa Fe over mountainous and generally poorly maintained state highways.[13] (*See Maps 3, 4, and 5.*)

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[11] MDH, Bk. 4, Vol. 5, p. 9.1 and App. B57, and Vol. 6, pp. 8.1, 18.2, App. B8, DASA; Matthias Diary, 6 May and 23 Jun 43, OROO.

[12] MDH, Bk. 8, Vol. 1, pp. 6.22–6.27 and App. B3, DASA.

Manhattan relied primarily upon motor buses to cope with its huge commuter problem. At Hanford, the Transportation Department regularly maintained, scheduled, dispatched, and operated more than 900 buses, making it probably the world's largest motor bus operator in a given area during World War II.[14] From April 1943 to March 1945, a total of 20 million passengers rode some 340 million miles on the Hanford system. The Tennessee bus system, which was maintained and operated by civilian firms under government contract, was considerably smaller. Nevertheless, by the end of 1944, more than 350 buses were in off-area service. In addition, a substantial number more, operated by Roane-Anderson's CEW Bus Authority formed in December 1943, provided service within the boundries of the site (as, for example, for the townspeople living in Oak Ridge). Manhattan regularly received assistance from the Transportation Corps, acting through its appropriate zonal commands, in procurement of most of the buses used at Clinton and Hanford and in the operation of its various bus systems.[15]

As on countless other war projects, thousands of Manhattan workers commuted in private automobiles. At Clinton, this was the major means of passenger transportation in the early stages of the project, and by early 1944 nearly twenty-five thousand automobiles were passing through the reservation gates each day. The Army took steps to supervise and control

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[13] Ibid., Bk. 4, Vol. 5, App. B1 (Area Mileage Tabs), and Bk. 8, Vol. 1, pp. 2.4–2.5 and 6.2–6.3, DASA; Du Pont Opns Hist, Bk. 16, "Transportation Department: Automotive Operations to July 1, 1945," pp. 1–2, HOO; CEW Passenger Trans Hist, pp 2 and 7, OROO; Completion Rpt, Stone and Webster, sub: CEW, pp. 12–13, OROO.

[14] Chicago, for example, with the largest city bus system in the United States, had some 800 buses in regular operation during the war. See MDH, Bk. 4, Vol. 4, "Land Acquisition, Hanford Engineer Works," p. 9.5, DASA.

[15] Ibid., pp. 9.1–9.5, DASA; CEW Passenger Trans Hist, pp. 11–39 and Exhibits B and D, OROO; Matthias Diary, 30 Oct 43, OROO; Du Pont Opns Hist, Bk. 16, pp. 1 and 7, HOO. At Hanford, Du Pont had responsibility for operation and maintenance of all project automotive equipment in plant areas and of that in Richland that was not under direct Army control.

OAK RIDGE BUS TERMINAL

this heavy traffic, encouraging share-the-ride programs; assisting employees in procurement of rationed tires and gasoline; and trying, without too much success, to provide automobile repair and maintenance facilities.[16]

Manhattan's heavy dependence upon buses and automobiles placed further strain upon existing road networks, which already were disintegrating under the pounding they received from the hundreds of trucks and other vehicles operated by the construction contractors. While the Army itself did not undertake to build and maintain roads for the project, area engineer personnel at each of the sites devoted much time to supervising the efforts made by the major construction firms to improve original roads, design and build efficient ne plant road networks and connectin routes, and maintain all road an highway facilities essential to projec operations. In most instances, the major contractors followed the practice of subcontracting road work t local construction firms that had equipment and working crews for the job.

Road development at Hanford will serve as an example of what in general was done at all the major sites. In January 1943, the site selection team had reported to General Groves that the road system of the Washington site consisted essentially of two main state highways: one running east from Yakima through what would become the heart of the production plant area, thence to Hanford and on to

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[16] CEW Passenger Trans Hist, pp. 44–51, OROO.

Spokane; and the other running from Richland to Hanford by way of the Yakima River horn. This major existing axis, plus a few secondary roads, eventually became the nucleus for a system of 350 miles of roads of all types, most of them asphalt surfaced, including two four-lane divided highways running from the vicinity of the pile and separation plants southeastward to Richland. When critics later questioned the wisdom of building these broad thoroughfares across miles of arid sagebrush grazing lands, Groves pointed out that they were consistent with the Army's policy of preparing for every forseeable contingency. Manhattan had to provide for the quick evacuation of thousands of workers in the event of an explosion, or similar accident, in the production area that conceivably might spread deadly radiation over a wide zone. Under the day-to-day supervision and inspection of the area engineer's staff, Du Pont planned and built the Hanford road system, employing two California road-building firms to do most of the actual earth moving, grading, and paving.[17]

Existing access roads near the Manhattan reservations were generally inadequate and poorly maintained. The Army improved the original off-site road networks to keep them in usable condition and arranged for construction of certain new connecting routes. Whenever and wherever possible, Manhattan tried to secure agreements with county, state, and federal highway officials for sharing the work of carrying out improvements on access roads. For example, in November 1943, District representatives met with officials of the state of Tennessee, the Public Roads Administration, Roane and Anderson Counties, and the principal contractors to work out an overall access road program, agreeing to assignment of priorities so that each project would be undertaken in order of its urgency. In carrying out the program, however, Manhattan found that while state and local highway officials endeavored to plan and build the sorely needed routes, they were unable in most cases to provide them in time to meet project requirements. Consequently, much access road work had to be done by Manhattan itself.[18]

Typical was the case of the Gallaher Bridge and Blair Roads. Manhattan submitted plans and specifications for these new roads to the Public Roads Administration in November 1943 as a basis for approval and allotment of the necessary funds, but the normal procedures of the Public Roads Administration and the Tennessee Department of Highways and Public Works preliminary to construction of a new road were so complicated and time-consuming that a start on building of the two access routes was not likely to be made until April 1944. Because the roads were needed urgently to provide good access from the west and north to the gaseous diffusion area, the Army built them as quickly as possible. The Real Estate Branch, Ohio River Division, Corps of Engineers, acquired the rights of way and the district engineer contracted with two road-building firms to do the actual construction. Work on the Gallaher Bridge Road started in mid-January and on the Blair Road at the beginning of February. Both roads were in use by May 1944.[19]

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[17] Prelim Rpt, sub: HEW Site Investigation, 2 Jan 43, Admin Files, Gen Corresp, 600.03, MDR; Matthias Diary, 7 and 17 Apr, 6 May, 27 Jul, 9 Nov 43, OROO; MDH, Bk. 4, Vol. 3, pp. 7.4–7.5, and Bk. 4, Vol. 5, pp. 7.9–7.11 and App. B4 (Summary of Contracts and Subcontracts), DASA; Du Pont Constr Hist, Vol. 1, pp. 5 and 9–10, and Vol. 4, pp. 484–85, 1089–92, 1094–96, 1101–06, 1111–12, HOO; Du Pont Opns Hist, Bk. 16, pp. 1–2, HOO.

[18] MDH, Bk. 1, Vol. 12, pp. 16.10–16.11, DASA; Matthias Diary, 17 Apr and 9 Nov 43, OROO; Du Pont Constr Hist, Vol. 4, p. 1096, HOO.

In spite of vigorous efforts, the Army experienced considerable difficulty in maintaining project road networks, especially those outside the reservations. Constant and heavy use of roads originally designed to carry only secondary traffic was one of the factors that contributed to maintenance headaches. Another was the problem of coordinating the activities of state, county, and local authorities who had responsibility for repair and upkeep of many of the off-area access roads. State and county maintenance crews were handicapped by lack of equipment, workmen, and funds. At Clinton, the Army employed its own project personnel and equipment for road maintenance, financing the work from funds allotted for the purpose by the Public Roads Administration. It followed a similar policy at Hanford, where the Public Roads Administration provided money to the Washington State Highway Department and local county highway departments. At the Los Alamos reservation, the Army hired road-building contractors to assist state and local highway crews in maintenance of off-site roads.[20]

Railroads

While Manhattan made extensive use of motor vehicles to transport manpower, it shipped most materials and equipment by rail. This meant construction of miles of spur lines and plant rail nets to connect installations with main-line railroads. The expense and effort could be justified because they eliminated costly and time-consuming shipment by truck from off-site railheads. Relatively few rail transport problems arose for the Army in Tennessee. But at the Washington site, Groves and the Hanford area engineer became involved in a prolonged controversy with some of the western railroads concerning both the quality and extent of service to be provided for the plutonium works.

The rail net at Clinton consisted of two separate and unconnected systems. Stone and Webster built and operated the eastern rail net—or Central System, the popular designation until Roane-Anderson took over in 1944—which provided service from the Louisville and Nashville's Cincinnati-Knoxville line to the town of Oak Ridge and the electromagnetic plant area. (*See Map 1.*) The western rail net, built and operated by J. A. Jones, provided the gaseous diffusion plant area with direct service from the Southern Railway's Cincinnati-Chattanooga line. The only plant area not directly served by rail was the plutonium semiworks. To cope with an early shortage of transportation for workers commuting from off-area towns, the Army obtained an order from the Office of Defense Transportation for

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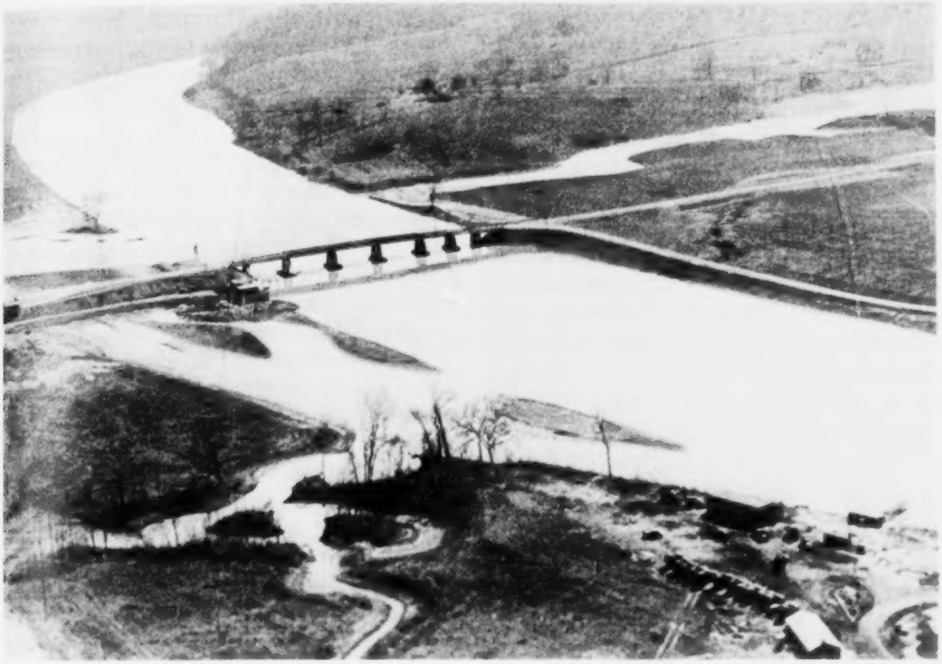
[19] MDH, Bk. 1, Vol. 12, pp. 16.11–16.12, DASA.

[20] Ibid., pp. 16.16–16.17, DASA; Du Pont Constr Hist, Vol. 4, p. 1096, HOO; Matthias Diary, 6 May and 9 Nov 43, OROO. Los Alamos project records available to the author did not reveal whether the state of New Mexico received funds from the Public Roads Administration.



GALLAHER BRIDGE ROAD AT THE TENNESSEE SITE

the Louisville and Nashville to operate passenger trains between Knoxville and Oak Ridge. This service, unwanted by the railroad company and never popular with the patrons, ended in the summer of 1944 when off-area bus service had increased sufficiently.[21]

One important feature of the Richland-Hanford area was its proximity to four main railroad lines: the Union Pacific; the Northern Pacific; the Spokane, Portland, and Seattle; and the Chicago, Milwaukee, St. Paul and Pacific. (*See Map 4.*) Only the Milwaukee Railroad's Priest Rapids Branch provided direct service into the site. This branch ran from the main line at Beverly Junction, located north of the site, some 46 miles (25 of them within the project area) south and east along the Columbia River to White Bluffs and Hanford, where it terminated. The other main-line railroads interconnected at Pasco, about 14 miles down river from Richland. Pasco was the location of a large Transportation Corps holding and reconsignment point with extensive warehouse facilities and a railroad siding. In February 1943, the Hanford area engineer arranged through the Corps of Engineers' Pacific Division and the 9th Service Command for transfer of the warehouses to the Manhattan District. Combined with expert assistance from Corps of Engineers officers assigned to the holding point, these facilities proved invaluable in handling the numerous shipments made to Hanford while the Priest Rapids Branch underwent extensive reconditioning.[22]

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[21] MDH, Bk. 1, Vol. 12, pp. 17.1–17.7 and 18.21, DASA; CEW Passenger Trans Hist, pp. 11 and 40–41, OROO; Completion Rpt, Stone and Webster, sub: CEW, pp. 20 and 167 (map), OROO.

Working closely with the area railroads, Du Pont drew up a rail service improvement plan for Hanford, with provisions for a thorough overhaul of the second-class Priest Rapids Branch and its extension from Hanford southward to Richland; for building of a complex access rail system in the plant area; and for construction of a southern rail connection to link Richland with the three major lines running out of Pasco to the south of the site. Consistent with this plan, the Milwaukee Railroad began reconditioning and extending the Priest Rapids Branch in the spring of 1943. Its objectives were strengthening the existing track bed and numerous trestle bridges so that heavier trains could be run over the line and, at the point where the branch entered the installation, constructing a large classification yard to serve as a switching point for cars entering the plant rail system.[23]

Although the Hanford Area Engineers Office closely supervised the Milwaukee Railroad's work, actively assisting in procurement of scarce rails, ties, rolling stock, and other items, there were interminable delays in deliveries and a general inability to cope with the ever-growing traffic. At Groves's request, Lacey Moore, a Corps of Engineers rail transportation expert serving as an adviser to the Hanford area engineer, inspected the branch in September. He noted serious defects in design of the line, including its excessive vulnerability to sabotage. Corrective measures by late November had somewhat improved conditions on the branch, leading Colonel Matthias to observe that "there is no question that the Milwaukee R.R. is now making every effort to meet the requirements of our service, and to expedite freight shipments as much as possible." [24] Yet systemic deficiencies continued to be a problem and were a cause of grave concern for several more months as construction activities at Hanford moved into high gear.[25]

The access rail system in the plant area comprised 125 miles of track, mostly in the northwest part of the site, and served the pile and separation plants, the metal fabrication and testing areas, and the administrative center at Richland. The Guy F. Atkinson Company of San Francisco, subcontracted by Du Pont, had responsibility for actual construction, with the Hanford area office providing considerable procurement assistance for hard-to-get rails, ties, rolling stock, and other equipment. Once completed, the Hanford area office and Du Pont jointly supervised operation of the plant rail net, with the latter providing operating personnel.[26]

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[22] OCE, Basic Data on HEW, 19 May 43, p. 12 and enclosed map, MDR; Matthias Diary, 23–25 Feb and 3 Mar 43, OROO; Du Pont Constr Hist, Vol. 1, pp. 9 and 16, HOO; Department of the Army, *The Army Almanac: A Book of Facts Concerning the Army of the United States* (Washington, D.C.: Government Printing Office, 1950), p. 153.

[23] MDH, Bk. 4, Vol. 3, pp. 7.5–7.7, and Vol. 5, pp. 9.2–9.3, DASA; Matthias Conf Notes, 1 Apr 43, Wilmington, Admin Files, Gen Coresp, 337 (Wilmington), MDR; Du Pont Constr Hist, Vol. 1, p. 152, and Vol. 4, pp. 1087–88, HOO; Matthias Diary, 23 Apr 43, OROO.

[24] Matthias Diary, 26 Nov 43, OROO.

[25] Matthias Diary, 1943–44, passim, OROO; Du Pont Constr Hist, Vol. 1, p. 152, HOO.

Strong support existed for construction of the proposed southern rail connection, which involved reconditioning existing lines and building several miles of new tracks and a bridge across the Yakima River. The major railroads in the area wholeheartedly favored its construction, because of obvious benefits to them. Manhattan supported the connection not only as a shorter route than the Priest Rapids line for freight coming from suppliers in the central plains and southern Midwest states but also as an alternate rail access in the event of sabotage. And Du Pont endorsed the connection because it was not at all certain that the Priest Rapids line would be able to move, on schedule, the undetermined—but obviously large—amount of construction materials that would have to be shipped by rail at the height of the construction period.

But the unsettled question over who should bear the burden of cost of new construction delayed any prompt action. When lengthy negotiations in the spring and summer of 1943 failed to produce an agreement, General Groves—determined to get a firm decision—personally visited Union Pacific President William Jeffers, who was in Washington serving as the War Production Board's rubber administrator. The informal understanding that resulted provided for construction of the southern connection by the Union Pacific and Northern Pacific Railroads, with the government bearing the entire cost of any new construction and the railroads agreeing to pay a user's fee.[27]

Despite the Groves-Jeffers understanding, the participating railroads were unable to break a stalemate over financial terms, and new legal bottlenecks loomed up suddenly. At the end of August, the Great Northern Railroad, joint owner with the Northern Pacific of the Spokane, Portland, and Seattle Railroad, began a formal investigation to ascertain why its area railroad had not been included in negotiations concerning the southern connection. Meanwhile, the Office of Defense Transportation informed Union Pacific that it would not approve a contract between the War Department and the railroads for construction of the southern connection and the Interstate Commerce Commission wrote to General Groves that the connection could not be built without its approval because it would constitute a link in an interchange between the through lines of the Milwaukee and the Union Pacific and Northern Pacific, which made it subject to ICC jurisdiction.[28]

When the Office of Defense Transportation issued an order in October prohibiting construction, in spite of a direct approach by Groves and the

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[26] MDH, Bk. 4, Vol. 3, pp. 7.6–7.7, and Vol. 5, pp. 5.30, 7.11–7.12, App. B4, DASA; Du Pont Constr Hist, Vol. 4, pp. 1085–86 and 1092–94, HOO; Matthias Diary, 19 Apr and 19–21, 31 May 43, OROO.

[27] MDH, Bk. 4, Vol. 5, pp. 9.2–9.3, DASA; Matthias Diary, Apr–Jul 43, passim, OROO; Groves Diary, 21 and 29 Jul 43, LRG; Du Pont Constr Hist, Vol. 4, p. 1091, HOO. Because the Priest Rapids line ran through mountainous terrain and across several rivers, it was more than usually susceptible to both land slides and sabotage.

[28] Matthias Diary, Jul–Aug 43, passim, OROO.

Under Secretary of War to ODT Chairman Joseph T. Eastman, the southern connection seemed doomed. At this juncture, Groves and the Hanford area engineer worked through channels in the Office of the Secretary of War to get the agency to reconsider the case. The area engineer achieved partial success in this direction in mid-November 1943, when ODT, 9th Service Command, and Transportation Corps representatives visited the Hanford installation. These officials, who were assessing traffic density on transcontinental rail systems, expressed the view "that the railroad connection was not only desirable but essential . . . [for dealing with] the great activity on the transcontinental lines which is due in the near future" and promised to recommend that it be given serious reconsideration.[29]

Manhattan used the possibility that the alternate connection might be constructed as a powerful lever to pressure the Milwaukee Railroad to improve the still far from satisfactory service over its Priest Rapids Branch. Thus, in December, General Groves told the railroad representatives that if they could maintain adequate service, "we [will] take no further action towards developing the connection. . . . We will, however, . . . continue our design and layout and other plans to insure their being ready to construct the Southern Connection if and when it is required." The strategy worked; service on the Priest Rapids Branch steadily improved in early 1944. But by mid-year, the plutonium works had reached its operational phase and rail service declined appreciably, thus obviating construction of the southern connection.[30]

Air Transport

Ever in a race against time, Manhattan frequently utilized air transport services to speed up movement of materials and personnel over the great distances separating its research and development centers, procurement facilities, and plant production areas. For the most part, Manhattan relied upon the services of commercial airfreight companies for shipment of such items as blueprints, parts, tools, and chemicals and on the Army Air Forces' Air Transport Command for movement of key personnel.

Because of the rough character of the terrain, neither Clinton nor Los Alamos had airfields within the reservation. Clinton used the Knoxville Airport, accessible over good roads some 25 miles southeast of the site; Los Alamos had to depend upon the Air Command's shuttle service into Kirtland Field at Albuquerque, some 114 miles by highway, parts of which were mountainous and often poorly maintained. At Hanford, where the terrain was relatively flat, Manhattan maintained a small airfield near the construction camp. In early 1943, the area engineer arranged with the Air Command to fly critical items to the Spokane Army Air Field, where a shuttle service picked them up and flew them to the Hanford airfield. In emergencies, the six Army airplanes of the Hanford security air patrol, piloted by civilians, were used to transport passengers and small freight items.[31]

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[29] Ibid., 28 Jul–16 Nov 43 (quotation from 16 Nov entry), OROO; MPC Min, 9 Sep 43, OCG Files, MP Files, Fldr 23, Tab A, MDR; Groves Diary, 2 Aug, 6, 21 and 28 Sep, 8 Oct 43, LRG.

[30] Matthias Diary, Sep–Dec 43 (quotations from 23 Dec 43 and 12 Jan 44 entries), OROO. Further evidence of the Milwaukee Railroad's intention of exploiting its control of the sole rail access line into the Hanford reservation was its application to the Interstate Commerce Commission to have the line from Beverly Junction to the project boundary abandoned as a common carrier. Fortunately, the commission did not approve this request, which would have required the District to move freight from Beverly Junction to the site or pay the railroad special switching charges for doing it. After further negotiations with railroad representatives in November, Groves and Matthias were able to reach a reasonable agreement on freight charges.

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[31] MDH, Bk. 4, Vol. 5, pp. 9.3–9.4, and Vol. 6, p. 8.3; and Bk. 8, Vol. 1, pp. 6.24–6.26, DASA. Du Pont Constr Hist, Vol. 2, pp. 498–99 and 551, HOO. Matthias Diary, 30 Apr and 8 May 43, OROO.

CHAPTER XX

Health and Safety

The health and safety of Manhattan Project personnel were essential to the success of the atomic bomb program. But in ensuring the workers' health and safety, the Army faced one of its most challenging administrative tasks because of the many unique and little understood hazards inherent in bomb development. Among these were the potentially deadly rays emitted by radioactive elements, the toxicity of a variety of chemical compounds and agents, the danger of high-voltage electricity employed in novel ways, the possibility of explosions in experimental work that involved the use of gas and liquids under great pressure and of high explosives as propellants, or even the likelihood of serious injury from metal objects cast about by tremendous magnetic forces.[1]

The Army knew that these unusual hazards must be properly controlled, for the lives of thousands of atomic workers were at stake. Although the Army had a long and outstanding record of carrying out public construction projects under extremely adverse and hazardous conditions, two factors peculiar to Manhattan made its task of devising and administering appropriate health and safety measures unsually complicated. One was the unrelenting urgency that prevailed in almost every aspect of the nuclear steeplechase to produce an atomic weapon before the enemy could do so, with the unfortunate result that project managers often were tempted to resort to shortcuts and speedy solutions that imposed greater health and safety risks. The other was the strict policy of compartmentalization, which prevented any widespread sharing of information and experience gained in dealing with special hazards. Fortunately, however, the Army was able to rely on its past experience on other projects and to build on the early measures of its predecessor, the Office of Scientific Research and Development (OSRD), to establish highly effective health and safety programs.[2]

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[1] Rpt, H. T. Wensel (Tech Secy, S-1 Ex Committee), sub: List of Hazards, Admin Files, Gen Corresp, 600.12 (Projs and Prgms), MDR; MDH, Bk. 1, Vol. 7, "Medical Program," p. 3.1, and Vol. 11, "Safety Program," p. 1.1, and Bk. 8, Vol. 1, "General," Sec. 6, and Vol. 2, "Technical" (Project 'Y' History), pp. III.38 and IX.19, DASA. Where not otherwise indicated, discussion of health and safety problems and practices in the Manhattan District is based on MDH, Bk. 1, Vols. 7 and 11, DASA.

[2] The OSRD policy permitted each research program to develop its own health and safety measures. For example, the Metallurgical Laboratory employed medical scientist Robert S. Stone, who had

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The Health Program

Manhattan's health program developed slowly but steadily during the first months of District operation. Health matters originally were the sole responsibility of a single medical officer, Capt. Hymer L. Friedell, who devoted most of his time to urgent pile process health problems at the Metallurgical Laboratory. But in early 1943, when the Army implemented measures to take over most OSRD contracts, Manhattan's modest administrative arrangements for health matters came under close review. As a consequence, pressed by a lack of adequately trained medical personnel, the District began its quest for expert assistance to monitor not only the existing OSRD programs but also those to be established by the Army in the future.[3]

Aware that few American medical scientists had the special knowledge needed to understand and solve the unique problems of the atomic program, General Groves launched a nationwide search for qualified medical personnel. The search revealed that a professor in the department of radiology at the University of Rochester, Stafford L. Warren, was mentioned most frequently as the best in his field. Professor Warren, Groves decided in February, was the medical scientist who, with the aid of the District staff, should coordinate the activities of all the individual health groups established and to be established by project contractors. Under the guise of discussing the radiological aspects of work to be done for the government by the Eastman Kodak Company of Rochester, Groves and the district engineer met with Warren at company headquarters. During the meeting they asked him to direct an important University of Rochester research program presumably related to the Eastman project, and also to serve part time as a medical consultant. When he indicated he was already fully involved in other wartime projects, including one for the OSRD, they asked him to take some time to think over the proposal.[4]

Meanwhile, Groves weighed the possibility of appointing either Major Friedell or medical scientist Robert S. Stone, who was working at the Metallurgical Laboratory on pile radiation hazards, but concluded that neither had the outstanding qualifications of Professor Warren. By giving Warren more specific information, the Manhattan commander reasoned, he might be persuaded. Groves immediately arranged for Warren to confer with other District officials concerning contractual provisions for the proposed research program at the University of Rochester and to go on an

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extensive knowledge and experience with radioactivity, and radiologist Simeon T. Cantril to develop a system to protect workers from the hazards of radiation in pile experiments. Similarly, the Radiation Laboratory launched a research program to investigate the best method for detecting the presence of phosgene, the highly poisonous gas that would be used in the electromagnetic plant's separation process. See Compton, *Atomic Quest*, pp. 176–78; Stafford L. Warren, "The Role of Radiology in the Development of the Atomic Bomb," in *Radiology in World War II*, Medical Department, United States Army, ed. Kenneth D. A. Allen (Washington, D.C.: Goverment Printing Office, 1966), pp. 832 and 845–46; MDH, Bk. 5, Vol. 2, "Research," pp. 4.10–4.11, and Bk. 8, Vol. 1, pp. 6.43–6.44, DASA.

[3] MDH, Bk. 1, Vols. 7 and 11, each p. 6.1, DASA; DSM Chronology, 11 Feb 43, Sec. 2(b), OROO.

[4] MDH, Bk. 1, Vol. 7, p. 6.1, DASA; Memo for File, Vincent C. Jones, sub: Telecon With Groves, 7 Jul 70, CMH.

inspection trip to some of the other atomic installations, including a visit to Oak Ridge to view a site for a hospital. Impressed greatly with what he saw, and now convinced of the crucial importance of the project, Warren agreed in March 1943 to become a full-time consultant to Groves with a view to eventual assignment as chief of the District's health program.[5]

Program Organization

At the end of June, Professor Warren became chief of a provisional medical section at District headquarters, with Major Friedell assigned as his executive officer and another Army doctor as his assistant. During the summer, as the section found itself overwhelmed with new health problems, Warren repeatedly asked for more personnel but his requests proved to be of little avail, resulting in employment of only two civilian physicians for the Clinton Engineer Works. Furthermore, the district engineer's announcement of the Medical Section's formal organization in August failed to include any provision for the much-needed additional personnel.[6]

Adequate staffing for the Medical Section awaited solution of the problem of how to recruit and hold medical personnel for at least as long as security and program continuity required. Medical personnel brought in to staff project medical facilities had to be privy to considerable secret data in order to perform their jobs properly. Manhattan's proposed solution was to militarize the medical staff, a step that would require collaboration with the Office of the Surgeon General (OSG).[7]

Following extended negotiations, Manhattan completed details of a working agreement with the OSG in September 1943. This agreement provided that the OSG, giving full cognizance to both the continuity and security required for the District health program, would furnish a broad range of medical assistance—for example, commission key District civilian medical personnel, provide additional trained personnel from the Army Medical Department, supply funds for the medical and dental care of District military personnel, and furnish medical supplies through Medical Department facilities for District use. To ensure that project security would not be compromised, the OSG appointed Col. Arthur B. Welsh as a liaison officer on its staff, giving him authority to approve all incoming requests from the District. The OSG also granted permission to the District's Medical Section to retain in its own files all reports that might reveal the nature, scope, or military significance of the project and agreed to secure approval from the district engineer for all transfers of Medical Department personnel from the project.

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[5] *Radiology in World War II*, pp. 841–42 and 848–49; Groves, *Now It Can Be Told*, p. 421; Memo for File, Jones, sub: Telecon With Groves, 7 Jul 70, CMH.

[6] *Radiology in World War II*, pp. 841–42; MD Cir Ltr, sub: Establishment of Med Sec, 29 Jun 43, Admin Files, MD Directives, Ser. 43, Declassification and Procedure, MDR; Memo, Nichols (for Dist Engr) to Warren, sub: Responsibilities of Med Sec, 10 Aug 43, copy in MDH, Bk. 1, Vol. 7, App. A1, DASA; Marsden Diary, 19 Jun 43, OROO. Colonel Marsden states that Warren sought authorization for an allotment of 110 medical officers.

[7] MDH, Bk. 1, Vol. 7, pp. 6.2–6.3, DASA; Ltr, Groves to CG ASF, sub: MD Med Facilities, 21 Sep 43, Admin Files, Gen Corresp, 371.2 (Scty), MDR.

These unusual arrangements with respect to security were consistent with the Manhattan-OSG agreement that responsibility for project health matters resided with the district engineer. The OSG had protested this provision, but the District had secured an order from General Somervell that upheld it, and it remained in effect for the duration of the Manhattan Project.[8]

On 2 November, shortly after the agreement became effective, Warren received his commission as a colonel in the Medical Corps and official appointment as chief of the Medical Section. One of his first actions was a reorganization of the section, to reflect the major areas of activity in the District's health program. He divided the unit into three branches: medical research, industrial medicine, and clinical medicine services; a fourth branch to oversee the Hanford health program never materialized, because Du Pont, the prime contractor, took over almost all responsibility for this activity. Another of Warren's concerns was to expand his staff by recruiting civilian physicians to serve in clinical assignments as commissioned officers. Warren's basic organization continued with little change up until July 1945 (except for the clinical branch, which then achieved the status of a separate division); however, in order to keep pace with the rapid growth of the project, he had to greatly expand its size—the original three-man staff eventually numbering eighty medical personnel.[9]

Active and continuing support not only from the OSG but also from a number of civilian medical organizations made possible the District's rather remarkable success in recruiting a relatively large and specialized medical staff in a period of the war when medically trained personnel were in extremely short supply. Especially valuable was the assistance provided by the national office and some local branches of the Procurement and Assignment Service.[10] State boards of medical and dental examiners, particularly those in Tennessee and Washington, granted concessions on licensing requirements. Numerous universities, medical schools, and biological institutes agreed to provide on a continuing basis medical specialists and technicians for District research laboratories and industrial hygiene teams.[11]

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[8] Ltr, Groves to CG ASF, sub: MD Med Facilities, 21 Sep 43, MDR; Blanche B. Armfield, *Organization and Administration in World War II*, Medical Department, United States Army (Washington, D.C.: Government Printing Office, 1963), p. 229; *Radiology in World War II*, pp. 846–47; Marsden Diary, 8 Oct and 2 Nov, OROO; Nichols, Comments on Draft Hist "Manhattan," Incl to Ltr, Nichols to Chief of Mil Hist, 25 Mar 74, CMH.

[9] MDH, Bk. 1, Vol. 7, p. 6.2 and Apps. C12a–C12e (Org Charts, MD Med Sec, May 43–Jul 45), DASA; *Radiology in World War II*, p. 843; Armfield, *Organization and Administration in World War II*, p. 229; Marsden Diary, 29–30 Oct and 2 Nov 43, OROO. Warren's eighty-man staff was comprised of seventy-two officers from the Medical Corps, three from the Dental Corps, three from the Medical Administrative Corps, one from the Veterinary Corps, and one from the Sanitary Corps.

[10] This was an agency established in November 1941 in the Office for Emergency Management, Executive Office of the President, to coordinate wartime allocation and employment of medical, dental, and veterinary personnel for all federal services, including the War Department. For further details on its organization and activities see John H. McMinn and Max Levin, *Personnel in World War II*, Medical Department, United States Army (Washington, D.C.: Government Printing Office, 1963), pp. 73–74 and 169–73

[11] MDH, Bk. 1, Vol. 7, pp. 1.5–1.6, DASA.

CLINIC
INFORMATION
AND
REGISTRATION

COL. STAFFORD L. WARREN *briefing the Oak Ridge hospital staff*

The unique opportunities presented by the District's health program also facilitated procurement of medical personnel. Medical scientists were quick to recognize that research in radiation had significant applications in the investigation of cancer, metabolism, and many other aspects of medicine. Fortunately, too, many had not been recruited for military service because their specialty did not relate directly to military medical requirements; Colonel Warren and a number of members of his staff were in this category. Others came from the field of internal medicine and from the basic biological sciences. Colonel Warren noted in retrospect that what these men all had in common, without reference to their specialty, was an interest "in using radiation or isotopes as tools to explore basic mechanisms in biologic systems."[12] The atomic bomb program promised an unexcelled chance to pursue this interest.

Medical Research

The basic objective of Manhattan's medical research program was collection of data on potentially damaging effects of radioactive and highly toxic materials so that measures and instrumentation could be incorporated into plant design and operations for the protection of atomic workers. An important corollary objective was to learn more about how to treat cases of overexposure to radiation and poisoning from toxic substances. Responsibility for the medical research projects at Manhattan laboratories and a number of universities and biological institutes under contract rested with the District's Medical Research Branch, headed by Major Friedell. Colonel Warren, too, with broad expertise in the areas under investigation, gave a great deal of attention to the various research projects.[13]

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[12] *Radiology in World War II*, p. 846.

Collection of medical hazards data was a direct outgrowth of expanding scientific investigations into the pile and electromagnetic methods of producing fissionable materials. More adequate data became essential as the number of workers involved in research activities increased and as planning began for large-scale production. For example, with the goal of establishing safety and health protection standards and developing safe operating procedures for the pile process, the Metallurgical Laboratory at the University of Chicago formed a health physics research group. Under direction of medical scientist Robert Stone, this group (numbering more than two hundred by mid-1945) conducted extensive investigations into the toxicity of radioactive materials, giving particular attention to their chemistry and pathology; designed monitoring instruments and pile shielding; and developed treatment programs for clinical medicine problems related to pile hazards.[14]

The University of Chicago–operated Clinton Laboratories in Tennessee had a similar research program. Although Stone had administrative responsibility for the Clinton program, he left actual direction to radiologist Simeon T. Cantril, who had worked under Stone at the Metallurgical Laboratory for more than a year. Using the pile semiworks, the Clinton team of scientists, physicians, and technicians tested the effects of radiation on animals and developed monitoring instruments for the Hanford production piles. Further investigations into the toxicity of radiation were carried out by other institutions under subcontract. For example, researchers at Columbia University in New York investigated the effects of fast-neutron dosages on mice, those at the Franklin Institute in Newark (Delaware) conducted similar tests on dogs, and those at the University of Washington in Seattle studied the exposure of X-rays and fission products on fish and fish eggs.[15]

Investigations at the Metallurgical Laboratory and Clinton Laboratories were supported and supplemented by the large University of Rochester medical research program. Under direction of Stafford Warren, scientists at Rochester pursued research in radiology, pharmacology, and instrumentation. The radiology section experimented with exposing animals to high-voltage X-rays and conducted beta radiation studies and genetic experiments relative to the effects of radiation on mice and fruit flies. The pharmacology group tested radioactive and potentially toxic chemical substances. Two groups concentrated on instrumentation problems, including the design of standard meters for measuring alpha and beta particles and gamma rays and the development of film and instrument monitoring methods and protective devices. To ascertain under actual operating conditions the validity of measuring instruments and protective devices, Rochester scientists tested them in the plants at Clinton, Hanford, and elsewhere in the project.[16]

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[13] MDH, Bk. 1, Vol. 7, pp. 5.2 and 5.16–5.17, DASA.

[14] Ibid., pp. 5.1–5.23, DASA; Compton, *Atomic Quest*, pp. 177–79; Groves, *Now It Can Be Told*, pp. 421–22.

[15] MDH, Bk. 1, Vol. 7, pp. 5.4–5.8, 5.13–5.14, 5.16–5.17, DASA; Groves, *Now It Can Be Told*, n. on p. 421; Compton, *Atomic Quest*, p. 177.

The Army believed these various research efforts would furnish all the data and instrumentation the Los Alamos Laboratory would need for its health program. But unique requirements of the bomb development program forced laboratory groups to launch separate medical research projects. In the spring of 1944, for example, essential monitoring apparatus was still not available, so members of the health and electronics groups combined their talents to develop the necessary instruments. Similarly, the industrial medicine group, faced with handling large quantities of fissionable plutonium, were dissatisfied with the available data on detecting overdoses, so they established their own research project, employing scientists from the health group and the metallurgical and chemistry division. These *ad hoc* research activities, born of necessity, contributed much to the success of other health and safety programs at the laboratory.[17]

Industrial Medicine

The major objective of Manhattan's industrial medicine research program was to identify and control the industrial hazards associated with the atomic processes. Effective application of the knowledge and techniques developed from this research was the responsibility of the District's Industrial Medicine Branch, headed by Capt. John L. Ferry. To monitor the project's various industrial hygiene activities, Ferry organized his staff from officers drawn from the Corps of Engineers and the Medical Corps.

Beginning with one specialized group to monitor the University of Rochester's industrial medicine research program, Ferry subsequently formed other groups to oversee the hazards program in materials procurement at the Madison Square Area Engineers Office, to deal with special problems wherever they might arise, to provide consultation on first aid and other aspects of operations medicine as needed, and to carry on liaison with the programs at the electromagnetic and diffusion production plants. Because of the special expertise of the Metallurgical Laboratory's health physics research group in dealing with pile process hazards, that group was given broad authority to monitor the industrial hygiene programs at the Clinton Laboratories, Hanford Engineer Works, and Monsanto Chemical Company plant in Dayton, Ohio. Ferry's branch did not have responsibility for the Los Alamos Laboratory's industrial hygiene program, which was under the direction of Washington University internal medicine specialist Louis H.

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[16] MDH, Bk. 1, Vol. 7, pp. 5.4, 5.6–5.8, 5.10, 5.15–5.16, 5.20–5.22, DASA; *Radiology in World War II*, pp. 852–53 and 862; Groves, *Now It Can Be Told*, pp. 421–23.

[17] MDH, Bk. 8, Vol. 2, pp. III.39–III.41 and IX.15–IX.16, DASA.

Hempelman, for the Army maintained oversight of the bomb development program through General Groves's Washington headquarters.[18]

Because of the shifting and unpredictable character of plant design, construction, and operational requirements, the Industrial Medicine Branch adopted a broad and flexible approach to its difficult task of monitoring the development of effective industrial hygiene measures. To ascertain the precise nature of industrial hazards, the branch had medical research scientists supplement their laboratory experiments with extensive observations in the field. The scientists gave medical examinations to plant employees to determine the potentially dangerous effects of handling large quantities of uranium and fluorine; they took dust counts in production plants to ascertain the amount of radioactive dust present in the different processes; and they detected areas where exposure to radiation was likely by having production workers wear X-ray film badges.[19]

As soon as sufficient information was in hand, the Industrial Medicine Branch drew up industrial hygiene standards and procedures that became the basis for recommendations to project contractors, who were responsible for their implementation. These recommendations generally took the form of bulletins or instructional materials. Typical were bulletins originally prepared by Kellex engineers and Ferry's staff for the firm's employees. They outlined approved methods for working with fluorine, uranium hexafluoride, hydrofluoric acid, and similar hazardous compounds, and included first aid procedures. The branch eventually gave these bulletins wide circulation wherever these substances were being employed. On occasion, when the Los Alamos health group requested supplemental training data for its educational program on plutonium-related hazards, the branch furnished the technical information.[20]

Through periodic inspections, the Industrial Medicine Branch maintained a check on contractors' compliance with its recommendations. Often the local area engineer would accompany branch inspectors on their rounds, exercising his authority to institute immediate changes when necessary. Frequency and thoroughness of inspections varied. Where the War Department had complete financial responsibility for all costs, as in cost-plus-fixed-fee contracts, the operating practices of the contractor—regardless of his industrial expertise or lack thereof—were likely to receive very close scrutiny. Where the industrial firm had primary liability, as under other types of contracts, inspections were more infrequent and less rigorous because of the firm's already proven record for controlling hazards. Branch inspection teams rated hazards control primarily upon results from more or less continuous checks upon employee health and from monitoring hazardous work areas, comparing the collected data with established standards.[21]

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[18] Memo, Nichols to Warren, sub: Responsibilities of Med Sec, 10 Aug 43, copy in MDH, Bk. 1, Vol. 7, App. A1, DASA. See also ibid., pp. 3.51–3.65 and Apps. C12a–C12e, DASA. The organization charts in the appendices indicate that medical personnel trained and indoctrinated at the Metallurgical Laboratory eventually occupied key positions in the hygiene programs at Clinton Laboratories, Hanford, and Monsanto. On the appointment of Hempelman see ibid., Bk. 8, Vol. 2, III.38–III.39, DASA, and Ltr, Oppenheimer to Groves, 25 Jan 43, Admin Files, Gen Corresp, 231.2 (Scientists), MDR.

[19] MDH, Bk. 1, Vol. 7, pp. 3.1–3.3 and 6.1, DASA; *Radiology in World War II*, pp. 868–70; Memo, Nichols to Warren, sub: Responsibilities of Med Sec, 10 Aug 43, DASA.

[20] MDH, Bk. 1, Vol. 7, pp. 3.1–3.3, DASA; Safety Committee, Bull SM-2, Safety Committee Regulations for Handling C-126 (Fluorine), Admin Files, Gen Corresp, 729.31, MD.

Chronologically speaking, among the District's first industrial hygiene problems were those in procurement and processing of uranium ore and in production of special chemicals (fluorine, fluorocarbons, and boron) required to manufacture fissionable materials. As industrial hygiene measures, the Industrial Medicine Branch recommended periodic physical examinations for workers exposed to hazardous conditions, use of protective clothing and masks, and installation of more effective ventilation systems.[22]

The principal hazard in the diffusion processes arose from the employment of highly toxic substances, including uranium in its oxide and hexafluoride forms, radium, and several fluorocarbons. While their use in small quantities for pilot plant testing presented little danger, their employment in enormously increased amounts in the production plants posed much greater hazards. To protect diffusion workers from these hazards, such as burns, lung irritation, or even kidney failure, the Industrial Medicine Branch collaborated with construction and operating contractors to install closed ventilation systems and to develop special handling techniques. The Carbide and Carbon Chemicals Corporation, for example, had its gaseous diffusion plant workers use protective clothing and Army-type gas masks when they repaired the hundreds of pumps that were cooled and lubricated with toxic fluorinated hydrocarbons. Similarly, the Fercleve Corporation had its thermal diffusion plant workers apply dry ice to solidify the highly volatile uranium hexafluoride gas before transferring it in or out of the system.[23]

The considerable hazards present in the research and development phases of the electromagnetic process were magnified during the production phase, thus proportionately increasing the control problem. Ironically, the most serious hazard, phosgene gas, was a deadly by-product of the most effective method of preparing charge materials for the production racetracks; other hazards included toxic dusts, radiation, carbon dusts, and toxic chemicals (principally carbon tetrachloride and trichloroethylene), and the use of high-voltage sources of electricity to operate the racetrack calutrons. As the operating contractor, the Tennessee Eastman Corporation collaborated with the District's Industrial Medicine Branch to institute a hazards control program. Protective measures developed included devices for detecting phosgene gas and monitoring dust concentration and toxic chemicals, as well as the requirement for physical examination of employees—particularly those who would have an above-average exposure to radiation emanations, uranium compounds, and other hazardous conditions.[24]

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[21] MDH, Bk. 1, Vol. 7, p. 3.1, DASA; *Radiology in World War II*, pp. 869–70; Groves, *Now It Can Be Told*, pp. 71–73.

[22] MDH, Bk. 1, Vol. 7, pp. 3.3–3.16, DASA; Safety Committee, Bull SM–2, Rev 2, MDR; Memo, Nichols to Brig Gen Thomas F. Farrell (Groves's Dep), sub: Shipment Scty, 20 Jun 45, Admin Files, Gen Corresp, 319.1 (Insp of Facilities at Rochester, N.Y.), MDR; First Annual Rpt, Murray Hill Area Engrs Office, sub: Proj S–37, 30 Jun 44, p. 19, OROO.

[23] MDH, Bk. 1, Vol. 7, pp. 3.19–3.27, and Bk. 2, Vol. 1, "General Features," p. 6.2, DASA; *Radiology in World War II*, pp. 856 and 859.

Of all the processes, hazards in the pile process were potentially the most dangerous, for there was little previous industrial experience on which to draw to devise adequate protective measures for atomic workers. Perils existed in each step of the process. In preparing uranium metal as fuel for the pile, there was radioactivity, uranium dust, and employment of highly acid cleaning substances; in pile operations, radiation and poisonous radioactive fission products; and in extraction and concentration of the end products, radioactive uranium slugs and very poisonous plutonium. To counter these hazards, project scientists and technicians worked with the Industrial Medicine Branch to develop a variety of control measures.

One of the most effective measures was the heavy shielding built into the production piles. Others included radiation-monitoring instruments with automatic alarms, which were placed in all exposed areas; periodic fingerprinting and physical examinations for workers; portable detection equipment, such as pocket ionization meters, film badges, and ring-type film meters; and protective clothing, respirators, and goggles. In those plant areas known to have radioactive beta or gamma emissions above the established tolerance level of 0.1 roentgen per 24-hour day,[25] plant health teams maintained a constant check of clothing and equipment for contamination. And in those situations where every possible protective measure still did not prevent exposure above the tolerance level, employees rotated in and out of the dangerous zones.[26]

Of the dangers facing employees at Los Alamos in bomb development operations, including exposure to radiation, work with high-voltage current, testing with high explosives, and handling of toxic materials and volatile gases, the single most serious hazard was work with fissionable plutonium. When the first shipments of plutonium began arriving in the spring of 1944, the Los Alamos health group exploited resources within the laboratory's own organization and formed special committees to devise and enforce the necessary controls for handling plutonium. While the committees concentrated on developing monitoring, decontamination, and other technical controls, the health group compiled and circulated appropriate health standards; established requirements for pre-employment and job-termination physical examinations; instituted tests for detecting overexposure of workers; improved the statistical records it maintained on individual employees; and carried out an educational program to instruct workers in the particular problems of plutonium. These efforts notwithstanding, laboratory operations with plutonium were plagued with a series of accidents.[27]

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[24] MDH, Bk. 5, Vol. 2, "Research," pp. 4.2–4.3 and 4.10–4.11, and Bk. 1, Vol. 7, pp. 3.31–3.35, DASA; *Radiology in World War II*, pp. 855–56; Questions and Answers Taken From Senate Atomic Energy Manual, ca. late 1945, Admin Files, Gen Corresp, 032.1 (Legislation), MDR.

[25] In May 1943, the Metallurgical Laboratory adopted the National Bureau of Standards radiation tolerance dose of 0.1 roentgen per 24-hour day. This was only one-half of the so-called international tolerance dose, established in 1934 by an international agreement, and it remained the standard for the atomic program until the end of the war. See *Radiology in World War II*, p. 853; Memos, Stone to Compton, 10 Apr and 15 May 43, Admin Files, Gen Corresp, 600.12 (Projs and Prgms), MDR.

[26] MDH, Bk. 1, Vol. 7, pp. 3.43–3.50, DASA; Memos, Roger Williams (TNX Div chief, Du Pont) to Groves et al., sub: Radioactivity Health Hazards at Hanford, 26 Jun 44, and Warren to Nichols, sub: Radiation Hazards, 1 Sep 44, Admin Files, Gen Corresp, 700 (Med Rpts, Health Prgm, etc.), MDR; Rpt, Cantril and Parker, sub: Status of Health and Protection at HEW, 24 Aug 45, Admin Files, Gen Corresp, 729.31 (Safety Prgm), MDR; Questions and Answers Taken From Senate Atomic Energy Manual, MDR; Groves, *Now It Can Be Told*, pp. 422–23.

Clinical Medicine Services

The primary objective of Manhattan's clinical medicine services program was to provide the thousands of project workers living on the closed and isolated atomic reservations with comprehensive on-site medical facilities. Providing full medical services, the Army felt, would enhance not only manpower recruitment but also work force retention. Another important benefit would be increased project security, for attending to the resident employees' personal medical needs on the reservation would obviate their having to seek treatment in the surrounding communities where services were often inadequate and limited. Accordingly, overseeing the establishment and operation of adequate on-site medical facilities—first aid stations, field dispensaries, outpatient and dental clinics, and full-service hospitals—became an important feature of the District's medical activities.

Unlike the medical research and industrial medicine programs, the clinical medicine program at each of the major atomic sites functioned with a minimum of external supervision. At Clinton, the Medical Section's Clinical Medicine Services Branch, headed by Lt. Col. Charles E. Rea, administered medical facilities provided by construction and operating contractors and the District. At Hanford, Du Pont established and monitored its own clinical medicine program, with the Medical Section exercising only a general supervisory role through a small liaison unit in the area engineer's office. And at Los Alamos, the post surgeon, Capt. James F. Nolan, a specialist in radiology and obstetrics and gynecology, administered the community medical services program under supervision of the post commander, who reported any medical problems directly to General Groves. The Manhattan commander, in turn,

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[27] MDH, Bk. 8, Vol. 2, pp. III.39–III.42 and IX.15–IX.18, DASA. For a list of major hazards at Los Alamos see Ltr, Oppenheimer to Robert M. Underhill (Board of Regents Secy, Univ of Calif), 15 Jan 44, Admin Files, Gen Corresp, 600.12 (Y-12), MDR. The shortage of certain types of safety equipment, the general lack of knowledge about plutonium, the rapid expansion of personnel and operations, and insufficient control over many technical procedures directly contributed to a series of accidents at Los Alamos, culminating in early 1945 in acute radiation exposure of four technical workers and the death of another during experimentation on critical assembly of fissionable material for the bomb. For a description of an accident during a bomb assembly test at Los Alamos see Ltr, Rudolph E. Peierls to James Chadwick, 7 Jun 45, Admin Files, Gen Corresp, 201 (Chadwick), MDR. On a subsequent accident in 1946, resulting in the death of Louis Slotin, an atomic scientist, see Robert Jungk, *Brighter Than a Thousand Suns: A Personal History of the Atomic Scientists*, trans. by James Cleugh (New York: Harcourt, Brace and Co., 1958), pp. 193–94 and 228–29.

Hazardous Materials Storage Area at Los Alamos. *Technicians are removing lead-lined container.*

consulted with Colonel Warren, who, in addition to being the Medical Section chief, also served as Groves's personal adviser on medical matters.[28]

Planning for the medical resources of the Oak Ridge community began in the spring of 1943, when Professor Warren and his University of Rochester staff developed a broadly conceived clinical medicine program. They recommended that the residents of Oak Ridge have access to a full range of medical services, to include surgery, medicine, pediatrics, obstetrics and gynecology, eye, ear, nose, and throat, psychiatry, proctology, neurology, urology, orthopedics, and dermatology. They also suggested the need for supporting X-ray and laboratory facilities.

Responding to these recommendations, District medical officials, working closely with both construction and operating contractors, took steps to provide for adequate medical facilities in the town of Oak Ridge. For workers requiring hospitalization they initially had planned to use off-site hospitals, but a survey of the surrounding communities, including Knoxville, revealed that the number of hospital beds available was well below the national average of 3.4 per thousand population. Because of the survey findings, the Medical Section decided to build a hospital in Oak Ridge that was substantially larger than required by the national average. A confluence of other factors also had entered into this decision. Of particular concern was the fact that more than an average number of workers were likely to require hospitalization in cases of serious illness or contagious disease, because they resided in dormitory-style dwellings or were members of families where everyone was employed. Compounding this concern was the consensus that there would not be enough physicians available to make home visits.[29]

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[28] MDH, Bk. 1, Vol. 7, pp. 4.1–4.3, 4.23–4.27, App C12, DASA; Groves, *Now It Can Be Told*, pp. 423–24; Ltr, Groves to CG ASF, sub: MD Med Facilities, 21 Sep 43, MDR. On the appointment of Nolan see MDH, Bk. 8, Vol. 1, p. 6.43, DASA, and *Radiology in World War II*, p. 879.

Construction began on a fifty-bed hospital, as well as a medical service building, in late 1943. But before either was ready for service, rapid population expansion had made both inadequate. With population figures revised from as many as ten thousand to fifty thousand in early 1944, the Medical Section authorized two additional wings, each with one hundred beds, and a fully equipped outpatient clinic. Again, however, community growth outstripped estimates, reaching seventy-two thousand in early 1945, and made necessary an additional sixty-bed wing. Even with the completion of this latter unit the hospital resources of the community were greatly strained in the spring of 1945, when there was an epidemic of severe upper respiratory infections among Oak Ridge residents.[30]

The pool of doctors, nurses, dentists, and other specialists to staff the Oak Ridge medical facilities burgeoned with the mushrooming population. To maintain the national wartime ratio of 1 physician to each 1,500 persons, the Clinical Medicine Services Branch procured Army Medical Corps personnel from the OSG and some civilians. From 8 doctors and 4 nurses in July 1943, the staff was increased to 25 doctors and 72 nurses in July 1944 and to 52 doctors and 144 nurses a year later, with analogous increases in outpatient treatments totaling 1,890 in July 1943, 10,403 a year later, and 19,599 in July 1945. Similarly, the branch enlarged the dental staff at Oak Ridge. From 2 dentists and 1 assistant in September 1943, the staff was increased to 29 full-time dentists and 23 assistants by March 1945. Most of the dentists were civilians, because their work did not require them to have access to classified information.[31]

The Oak Ridge clinical medicine services program also provided for the public health needs of the community. In the early months of community development, Army veterinarians cared for government-owned animals of various kinds—horses, sentry dogs, test animals—in use on the reservation and assisted community officials in meat and milk inspections.

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[29] MDH, Bk. 1, Vol. 7, pp. 4.1–4.4 and 4.13–4.14, DASA.

[30] Ibid., pp. 4.1–4.7, and Vol. 12, "Clinton Engineer Works," pp. 10.1–10.4 and 10.9–10.10, DASA; Completion Rpt, Skidmore, Owings and Merrill (architect-engineer), sub: Portion of Townsite Planning of Oak Ridge, Contract W–7401–eng–69, 9 Sep 44, pp. V.10, V.25–V.28, V.30–V.31, OROO; Robinson, *Oak Ridge Story*, p. 56; Groves, *Now It Can Be Told*, p. 423.

[31] MDH, Bk. 1, Vol. 7, pp. 4.14–4.19, and Vol. 12, pp. 10.5–10.7, DASA; Completion Rpt, Skidmore, Owings and Merrill, sub: Portion of Townsite Planning of Oak Ridge, 9 Sep 44, p. V.29, OROO; Groves, *Now It Can Be Told*, p. 424; *Radiology in World War II*, p. 874.

Oak Ridge Hospital (*multiwinged structure in foreground*)

With the establishment of a formal public health service in January 1944, they also oversaw rabies inoculation of pets and maintained the dog pound and an animal hospital. The public health service, which functioned very much as did that in a private civilian community of comparable size to Oak Ridge, devoted detailed attention to food production and handling, inspection of water and sewage facilities, and control of communicable diseases. And with films, newspaper articles, and special schools, it kept community residents and plant workers informed concerning the latest developments and most effective means for maintaining suitable public health conditions.[32]

Two aspects of the Oak Ridge clinical medicine program were unusual for the times: a psychiatric and social welfare consultation service, available to both civilian and military residents; and a low-cost medical and dental insurance plan (the Oak Ridge Health Association), which was patterned after the California Physicians Service. Both contributed significantly to reducing the turnover of trained workers, a persistent problem throughout the war. Dental coverage subsequently proved financially unworkable and was abandoned, but comprehensive medical care continued as a permanent feature.[33]

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[32] MDH, Bk. 1, Vol. 7, pp. 4.20–4.23, and Vol. 12, pp. 10.7–10.9, DASA: *Radiology in World War II*, p. 872.

The Hanford clinical medicine services program was essentially civilian in character. Du Pont, not the Army, had primary responsibility for its direction, which was consistent with Manhattan's larger policy of granting the company the maximum autonomy possible with efficient operation. Few Army personnel were directly involved, and there was no effort to militarize the civilian medical staff. Also, as at Clinton and Los Alamos, the District did not maintain special medical facilities at Hanford for military personnel. Instead, the relatively small military contingent depended upon the contractor-administered services for its medical and dental needs.[34]

In early 1943, Army leaders had few precedents for entrusting medical care of tens of thousands of atomic workers to a private industrial firm. From 1943 through 1945, Du Pont had to cope with problems similar to those in Tennessee, including a rapidly expanding population, the necessity for maximum secrecy, and a remote location. In certain respects, however, its problems were more difficult because of the greater isolation of the site and the much larger proportion of workers living on it. Nevertheless, the Hanford clinical medicine program—including regular medical services, emergency dental care, and public health—was a success. A close observer of the program, the director of health of the state of Washington, commented in 1944 that he knew of "no industry in this state doing a more adequate and as thorough a job as is being done at the Hanford Engineer Works." [35]

Residents of Los Alamos, as did residents of Manhattan's other atomic reservations, had access to complete medical services. Provision of these services was perhaps even more essential at the bomb laboratory than at Clinton and Hanford. The location of the New Mexico site was more than 50 miles via a tortuous mountain road to the nearest hospital. The highly secret nature of the work made it imperative, from the security standpoint, that all travel away from the post—including that for medical purposes—be limited to an absolute minimum. A final factor, and one of central importance, was maintenance of high employee morale, for so many members of the scientific and technical staffs who had to work at a forced-draft pace would find little opportunity for relief from the unremitting pressure of trying to solve extremely difficult problems.[36]

In the first year of Los Alamos operations, medical facilities were extremely limited. For civilian patients there was only a five-bed industrial infirmary (eventually, through severe overcrowding, it accommodated twenty-four bed cases), staffed by two physicians and three civilian nurses. For military personnel the Army provided a separate three-bed infirmary, staffed by a Medical Corps officer and seven enlisted men. With the Army's Bruns General Hospital in Santa Fe available for civilian residents requiring lengthy hospitalization or special treatment, these modest facilities sufficed as long as the population of the site remained relatively small. Dependence upon Bruns Hospital, however, presented some serious drawbacks. The time-consuming trip to Santa Fe resulted in a loss of man-hours, which the project could ill afford. There also was the inherent risk to security in having personnel leave the reservation, even though the trips were carried out under military supervision.

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[33] MDH, Bk. 1, Vol. 7, pp. 4.7–4.13, and Vol. 12, pp. 10.5 and 10.8, DASA; *Radiology in World War II*, pp. 874–75; Robinson, *Oak Ridge Story*, p. 56.

[34] This and the following paragraphs are based on MDH, Bk. 1, Vol. 7, pp. 4.23–4.25, 4.28, 4.30–4.31, 4.37–4.39, and Bk. 4, Vol. 5, "Construction," App. B66 (Org Chart, Constr Div, HEW), and Vol. 6, "Operation," App. B10 (HEW Org Charts, Contractors), DASA; Ms, Roy C. Hageman, "Hanford: Threshold of an Era," 1946, pp. 26–27, Admin Files, Gen Corresp, 461 (Hanford), MDR; *Radiology in World War II*, pp. 875–78.

[35] Ltr, Dr. Lee Powers (Wash State Health Dir) to E. L. Plenninger (HEW Proj Supt), 25 Sep 44, Admin Files, Gen Corresp, 700 (Diseases, Cancer Research), MDR.

[36] MDH, Bk. 8, Vol. 1, pp. 2.4–2.6, and Vol. 2, pp. III.12–III.13, DASA; Groves, *Now It Can Be Told*, pp. 164–66.

A reassessment of the post's limited medical facilities occurred in late 1943 in order to meet the increased health needs of a rapidly expanding population, which had not only more than doubled in size but also had changed in composition. Beginning in January with only fifteen hundred construction workers, the population by the end of the year had expanded to over thirty-five hundred and now included scientists, technicians, University of California and civil service employees, military personnel, and dependents. Providing them with proper medical care was essential, especially for the larger proportion of individuals who were likely to require hospitalization. Several factors occasioned this situation: An increasing number of workers had been rejected for military service for medical reasons; a higher percentage of young married couples were likely to need obstetrical services and medical care for small children; and a sizable element of the civilian population lived in barracks or dormitories. Hence, Captain Nolan recommended to Lt. Col. Whitney Ashbridge, commanding officer of the post, that the industrial infirmary be expanded into a 60-bed hospital, to include a 30-bed convalescent ward for use by both civilian and military patients. Nolan did not get all that he requested, but with Colonel Warren's support he secured authorization for expansion of the infirmary into a 54-bed unit. Because civilian medical personnel were virtually unobtainable by mid-1944, most of the additional staff had to come from the Army Medical Corps.[37]

By late 1944, the New Mexico community had reasonably complete clinical medicine facilities. Most services were available to permanent residents at little or no cost, the only exceptions being that civilian in-patients at the hospital paid a subsistence fee of $1 a day and construction contractors paid at established rates for emergency treatment of their personnel. Until early 1944, periodic visits by dentists from Bruns General Hospital provided the only on-site dental care, but in March a full-time dentist became available at the Los Alamos hospital. Veterinary services had come much earlier, when the military police detachment at the post brought in a medical officer in April 1943 to look after the horses and war dogs used on security patrols. Under direction of Captain Nolan, the post veterinarian and his staff cooperated with the clinical medicine staff to establish and maintain public health services for the community.[38]

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[37] MDH, Bk. 8, Vol. 1, pp. 6.43–6.47 and 7.15, DASA. Memo, Warren to Groves, sub: Hospital Requirements at "Y," 22 Jun 44; Memo, Warren to Groves, sub: Insp of Med Facilities at "Y" (24–28 Oct 44), 16 Nov 44; Memo, Nolan to Ashbridge, sub: Med Facilities and Activities in the Year 1943–44, 9 Jun 44. All in Admin Files, Gen Corresp, 319.1 (Hospital), MDR.

As a major factor in maintaining community morale, the clinical medicine services program was perhaps more significant at Los Alamos than at any of the other atomic sites. This was particularly the case during the hectic months of bomb development and testing in late 1944 and early 1945. In this period, the strain of working long hours on extremely difficult technical problems in the face of pressing deadlines combined with the stress of other factors—geographic isolation of the site, limited recreational opportunities, strict security requirements including censorship of mail, and not always adequate living conditions—to place a severe burden on both individual and community morale.

In August 1944, Colonel Warren sent a psychiatrist to the New Mexico site to survey the situation. The psychiatrist found that "dissatisfactions were expressed by every category of resident interviewed." He recommended that a psychiatric social worker would help ease tensions and remove frictions in the civilian population and more intensive efforts by the post chaplain and the WAC commanding officer would improve relationships among the diverse military groups. Warren acted promptly to put these recommendations into effect. In the follow-up survey made in April 1945, the psychiatrist found community morale greatly improved. And in the final hectic weeks of bomb assembly and testing in the summer of 1945, no key scientists or technicians were lost to the effort because of illness or mental breakdown.[39]

The Safety Program

Start of large-scale project construction activities in the spring of 1943 brought the first big upsurge in safety problems for the Manhattan District. Anticipating this increase, Colonel Marshall had transferred the only safety engineer on his headquarters staff to the Clinton Engineer Works. Consequently, in early 1943, he began to look for a replacement, this time seeking an engineer with the ability and experience to organize and direct a project-wide safety program. Not until June did he find the man he wanted. James R. Maddy was a veteran in the safety field, with broad experience and an outstanding record of achievement on other government projects. Marshall's instructions to his new safety engineer were to form from the District's existing safety staff a separate section with sufficient personnel and expertise to oversee all Manhattan safety activities.[40]

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[38] MDH, Bk. 8, Vol. 1, pp. 6.47–6.49, DASA; Groves, *Now It Can Be Told*, p. 166.

[39] Quotation from Memo, Dr. Eric Kent Clarke (consultant to MD) to Warren, sub: Mental Hygiene Survey at "Y" (23–27 Aug 44), 29 Aug 44. See also Memo for File, Clarke, sub: Psychiatric Problems in Community at "Y," 2 May 45. Both in Admin Files, Gen Corresp, 700 (Disease, Cancer Research), MDR.

[40] MDH, Bk. 1, Vol. 11, pp. 6.1–6.6 and App. C15, DASA; Marsden Diary, 2 Jun 43, OROO.

Program Organization

Maddy's program organization coincided with the move of District headquarters from New York to Oak Ridge. The newly established Safety-Accident Prevention Section (in late 1944 it became a branch) henceforth became responsible not only for the project-wide safety program but also for the Clinton program. At the same time, however, the policy of granting Hanford greater administrative autonomy relieved the section of all but very general supervision of its safety program.[41]

By the end of 1943, Maddy had a staff of fifty full-time employees assigned to five subsections (construction, industrial, training, traffic, and community safety). In subsequent reorganizations he consolidated the construction and industrial units to form an Occupational Safety Section and the traffic and community units to create a Public Safety Section. Maddy's headquarters section supervised the program through resident safety engineers, one of whom was assigned to each field activity where exposure to hazards amounted to at least eighty thousand man-hours per month and, beginning in May 1945, one to the staff of each officer in charge of a major operating division at Clinton. The resident engineer was usually a member of the area engineer's staff, performing the dual function of advising the area engineer on safety matters and maintaining liaison between his area and the safety office in Oak Ridge.[42]

Maddy managed the District's safety program with only modest additions to the personnel of the Safety-Accident Prevention Section. This he was able to do by close adherence to General Groves's basic policy of making maximum use of available assistance from existing outside organizations operating in the safety field. Thus, wherever feasible, he relied upon the existing safety organizations of the prime contractors, such as Du Pont and Kellex, who employed full-time safety engineers. Similarly, in community safety matters he encouraged voluntary safety committees, although these were not always as effective as relying on professional safety engineers. This was the case in Oak Ridge, for example, where the collaborative efforts of Roane-Anderson and a volunteer committee for a community safety program proved less efficient than the expertise of Maddy's office.[43]

The safety program also received indispensable assistance from the Office of the Chief of Engineers (OCE). Groves had established an effective liaison with the OCE's Safety and Accident Prevention Division, enabling Manhattan safety personnel to secure materials on standards and requirements, special studies, and even personnel. Similar liaison arrangements with the Department of Labor and the Bureau of Mines provided a source of training materials and, from the Bureau only, safety instructors.

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[41] MDH, Bk. 1, Vol. 11, pp. 6.1–6.2, DASA; Matthias Diary, 12 and 24 Sep 43, OROO.

[42] MDH, Bk. 1, Vol. 11, pp. 6.2–6.5 and Apps. A6–A9 (Org Charts, MD Safety Org, 1943–45), DASA.

[43] Ibid., pp. 6.2–6.3 and 6.7–6.8, DASA.

Also many nongovernmental organizations—most notably the National Safety Council, American Red Cross, and International Association of Chiefs of Police—supplied technical data and special training. With this extensive outside assistance, District safety employees could devote most of their time to solving urgent current problems.[44]

Occupational and Community Aspects

At the Tennessee and Washington sites, separate staffs administered occupational safety for the worker on the job and community safety for residents of the atomic communities. In each production plant at Clinton, a resident engineer coordinated safety measures with the appropriate construction and operating contractors. At Hanford, Du Pont's own safety department, assisted by a central safety committee comprised of all department heads and with advice from the area engineer's safety office, administered occupational safety. Community safety at Oak Ridge was the responsibility of a full-time safety director functioning under supervision of the resident engineer for the central facilities and at Richland, of the area engineer's safety office. At the New Mexico site, where the production organization and community were much more closely integrated, a safety committee oversaw both occupational and community safety until early 1945. That year the Los Alamos administrative board employed a full-time professional safety director, who later divided safety activities between a community program and a technical area program.[45]

Manhattan's occupational safety program came to resemble that found in many large-scale wartime industrial enterprises. The District safety staff promulgated a great variety of regulations intended to minimize job-related injuries and illnesses. These required contractors to provide workers with safe drinking water, goggles, hard hats, safety shoes, and similar items; to submit monthly reports on all accidents; and to incorporate thousands of safety features in plant buildings and equipment. Compliance with established safety codes and standards was verified through on-the-spot inspections. To support the efforts of resident safety engineers and contractors, the safety staff developed a program of safety indoctrination for all employees, provided materials for special courses, issued safety rule books, and carried out a continuing program to publicize safety matters in community and plant newspapers, in films shown in local theaters, and in widely displayed posters.[46]

On the whole, the community safety program was more conventional. Oak Ridge, Richland, and Los

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[44] Ibid., pp. 6.9–6.10, DASA; Rpt, Natl Safety Council, sub: Community Safety Prgm, Oct 43 (for CEW) and Nov 43 (for HEW), with supplementary reports made at each site in 1944, OROO.

[45] MDH, Bk. 1, Vol. 11, pp. 6.4–6.5 and Apps. A6–A9; Bk. 4, Vol. 5, Sec. 10, and Vol. 6, Sec. 7; and Bk. 8, Vol. 1, p. 6.63, and Vol. 2, III.38 and IX.19, DASA. Most other Manhattan installations having more than eighty thousand man-hours of exposure to hazards per month had a full-time safety engineer. The exceptions were Boston, where Stone and Webster's work was not sufficiently hazardous to require special safety measures, and Berkeley, where the University of California accepted complete responsibility for safety matters.

[46] Ibid., Bk. 1, Vol. 11, pp. 2.1–2.11 and Apps. C11 and H4 (Safety Progress Rpts), F1 and F4 (Safety Tng Bulls), F6 (Safety Films), DASA.

Alamos required essentially the same provisions for the safety of their residents as most normal American towns of comparable size and population, but with certain significant differences. One was their unusually great dependence upon automobile transportation, creating special traffic problems. Another was security, making it necessary for the military to perform certain safety functions usually assigned to civilian agencies, as, for example, fire safety and the enforcement of traffic regulations. On the other hand, the programs for safety in public places (theaters, recreation centers, playgrounds), in schools, and in the home were not unlike those in effect in most American communities.

District traffic engineers carefully studied various statistical reports on road congestion and accidents and devised corrective measures, including institution of such advanced concepts as radio control of traffic flow, unbalanced lanes for inbound and outbound rush-hour traffic, and ingenious layouts to expedite turns. They also drew up traffic regulations based on the Uniform Vehicle Code in force in many states, and therefore familiar to most of the residents in the atomic communities, and distributed copies of these regulations widely among District drivers.[47]

As a check on the public safety standards and as an additional source of professional expertise, the Army requested National Safety Council experts on home, school, and traffic safety to make periodic surveys. After each survey the council issued recommendations, most of which the district adopted. Thus, in early 1944, Maddy reported to the district engineer that of the sixty-nine recommendations the council had made in a survey of Oak Ridge, the District had adopted thirty-two and was in the process of adopting twenty-one others, more than a third of them relating to traffic problems.

A continuing problem for the District safety staff was how to maintain a high level of adherence to project safety regulations. Among the factors that tended to reduce attention to safety requirements below an optimum level were inadequate knowledge of current regulations or a general decline in morale, which occurred among atomic workers in 1944 and early 1945. One effective means was to hold a safety exposition, presenting a combination of entertainment and exhibits designed to build up morale and at the same time teach safety measures. In the hectic last months of the war, thousands of project employees at Clinton and Hanford viewed highly successful safety expositions on industrial, off-the-job, and home safety.[48]

A precise assessment of the Manhattan District's relative success in its public safety program is difficult because of a lack of detailed statistical records. Nevertheless, there is some evidence that by 1944 the atomic communities were achieving a public safety record at least equal to that in long-established civilian towns of comparable size. Traffic safety was a specific case. Workers commuting from Oak Ridge and Richland to the atomic plants were abnormally dependent upon motor vehicles driven unusually long distances over roads often poorly built and maintained. Yet their record of traffic safety was as good as that of war workers in comparable civilian communities commuting under far less hazardous conditions. And in fact during one specific period in 1944, Oak Ridge drivers had fewer fatalities per 10,000 vehicles in operation than towns of similar size in other parts of the country.[49]

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[47] Ibid., Bk. 1, Vol. 11, pp. 3.1–3.7 and Apps. C12 (Traffic Regs for CEW) and D3–D4, and Bk. 8, Vol. 1, pp. 6.33–6.35, DASA. In addition to District regulations, government drivers operating in the atomic communities had to comply with strict Corps of Engineers requirements for vehicle inspection, driver training, and driver records maintenance.

[48] MDH, Bk. 1, Vol. 11, p. 3.8 and Apps. E7–E9 (Photos of Safety Exhibits), DASA; Memo, Groves to Office of the Fiscal Dir, HQ ASF, Attn: E. F. Naylor (Spec Asst), sub: HEW Safety Exposition (24–29 Jul 44), 24 Sep 45, Admin Files, Gen Corresp, 729.31 (Safety and Evacuation, Hanford), MDR.

In December 1945, the National Safety Council presented the Manhattan Project with the Award of Honor for Distinguished Service to Safety in recognition of its unusually low incidence of occupational accidents from January 1943 through June 1945, resulting in 62 fatalities and 3,879 disabling injuries during 548 million man-hours. This record, statistically speaking, gave the District an occupational injury rate 62 percent below that for equivalent private industry. Viewed in another way, District safety programs, compared with the national average, could be credited with having saved 94 lives, prevented 9,200 disabling injuries, and contributed an additional 814,000 employee-days-of-work to the project. In some respects, a more important achievement was that effectiveness increased during the thirty-month period, as demonstrated by the steady decline of the frequency, fatality, and severity rates of injury among District workers.[50]

Insurance Plans

Acqusition of normal insurance coverage for the atomic project was virtually impossible. Even if complete disclosure to a group of insurance companies had been possible, they would have been unable to write coverage because of the lack of knowledge and understanding of the hazards involved, the extent and duration of the effects these hazards might cause, and the ramifications of any large-scale nuclear-related accident that might occur. Consequently, where normal insurance was not possible, the government had to assume full responsibility for any claims that might result.

Consistent with provisions relating to insurance in the First War Powers Act of 1941 and to procurement of coverages in War Department Regulation 4, Manhattan developed an insurance plan to protect the interests of the government and project contractors and employees. The number of insurance carriers was limited deliberately to prevent knowledge of the project from becoming too widely known in the insurance industry, and District officials often had to perform investigations, determine merits of claims, conduct inspections, and examine contractors books on behalf of the insuring companies. The District's Insurance Section, organized in August 1942, supervised these activities and helped administer a variety of insurance rating plans and types of insurance for project contractors, including guaranteed costs, industrial accident and health, employees benefits, and group insurance.[51]

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[49] MDH, Bk. 1, Vol. 11, pp. 5.7–5.8 and Apps. B2 (Traffic Survey at Tenn. Site) and C12 (Traffic Regs for CEW), DASA.

[50] Ltr, Ned H. Dearborn (Natl Safety Council president) to Groves, 18 Sep 45, Admin Files, Gen Corresp, 200.6 (Natl Safety Award), MDR; Rpt, Cantril and Parker, sub: Status of Health and Protection at HEW, 24 Aug 45, MDR. See also MDH, Bk. 1, Vol. 11, pp. 5.1–5.6 and Apps. A2–A5 (graphs showing occupational injury rates for MD) and B3 (tables showing occupational injury experience for MD), DASA.

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[51] MDH, Bk. 1, Vol. 6, "Insurance Program," DASA; Groves, *Now It Can Be Told*, p. 57.

CHAPTER XXI

The Atomic Communities in Tennessee

Those mid-twentieth century Americans who came by the thousands to live in the burgeoning atomic communities of the Clinton Engineer Works (CEW) in east Tennessee moved into a region with deep roots in the nation's history. European settlers had been coming from the eastern seaboard colonies for two hundred years, many by way of the much-traveled trail through the Cumberland Gap, to live in the valleys beneath the heavily wooded ridges forming the foothills of the Cumberland Mountains. But their numbers had remained small, limited to the few farm families that the relatively poor soil would support. Then in the 1930's, the arrival of the Tennessee Valley Authority (TVA) presaged the establishment of the "Government village" that in the next decade would tremendously alter the quiet rural countryside.[1] Indeed, as the Manhattan Project got under way in early 1943, the sudden influx of the atomic workers soon created a unique industrial community along the south slopes of that prominent terrain feature known for many years as Black Oak Ridge.[2]

Oak Ridge: The Operating Community

Of necessity, planning for community facilities related directly to the construction and operation of the production plants and hence was subject to frequent revision, usually toward expansion. Rather than adhering to long-range blueprints, Manhattan was compelled to adopt a policy of expediency, responding as promptly as possible to each new major change in industrial development, with the hope that it could provide at all times for at least a minimum of community requirements. Achievement of even this minimum goal often was difficult, because the Army's general policy gave first priority to materials, equipment, and manpower for plant construction and operation.[3]

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[1] Manhattan and Stone and Webster engineers regularly used the term *Government village* to designate the community they envisioned would be built at the Clinton Engineer Works as an administrative headquarters and residence for construction and operating workers. See reference in Marshall Diary, 9 Jun and 24 Jul 42, OCG Files, Gen Corresp, Groves Files, Misc Recs Sec, behind Fldr 5, MDR.

[2] Robinson, *Oak Ridge Story*, pp. 32–41; U.S. Atomic Energy Commission, *AEC Handbook on Oak Ridge* (Oak Ridge, Tenn.: Oak Ridge Operations Office, 1958), p. 11.

First Phase, 1942-1943

Organization and planning for Oak Ridge began in late June 1942, after Stone and Webster had agreed to include site development and housing construction in its responsibilities as architect-engineer-manager of the atomic project. Meeting with Manhattan leaders on the twenty-ninth, company officials indicated a special engineering group at their Boston office would begin design work for the permanent operating community immediately. During the weeks that followed, Stone and Webster and Army engineers collaborated closely on preliminary plans for the community. Using such previously built government villages as Ocala, Florida (for the Florida ship canal project), and Eastport, Maine (for the Passamaquoddy project), as a basis, they envisioned an operating village of some five thousand inhabitants.

Following a visit to the Tennessee site, the engineers tentatively decided that the best location for the village would be in the northeastern corner because Tennessee 61, the best highway traversing the site, ran northeastward to Clinton and then connected with good roads to Knoxville, and also because main lines of the Louisville and Nashville Railroad and the Southern Railway were nearby. (*See Map 3.*) The topography, too, met their requirements. The stream valley formed by the East Fork of Poplar Creek, a tributary of the Clinch River, was relatively flat—if somewhat narrow—and extended about 7 miles southwestward from the northeast boundary of the reservation. And paralleling the valley on the north and south were Black Oak Ridge and Pine Ridge, foothills that would provide the necessary protection for the future community from possible disastrous explosions at the nearby production plants and from unauthorized observation from outside the reservation. The gentle slope of Black Oak Ridge also promised to be suitable for residential construction.[4]

Because the site under construction was remote and all personnel, for safety and security, would have to live in one place, the village would need numerous housing units and facilities to provide atomic workers with minimum standards of comfort and service. But wartime restrictions on the amount and cost of any kind of community construction and the difficulty in procuring building materials made it seem unlikely that adequate facilities could be provided. Thus, both Brig. Gen. Lucius D. Clay, in his capacity as the Services of Supply's deputy chief of staff for requirements and resources, and Colonel Groves, who was still serving as the Corps of Engineers' deputy chief for Army construction, took occasion to remind District officials of these restrictions and to caution them against overly elaborate plans for village construction. Clay told Colonels Marshall and Nichols that he saw little hope that there would be any relaxation in these restrictions for the atomic project. Groves reaffirmed this view and made a point of reminding Marshall of the $7,500-dollar cost limitation on individual quarters; he also told Captain Johnson, the District liaison officer in Washington, D.C., that he thought patterning the atomic community after Ocala or Eastport would be a mistake, for these two towns were built under peacetime conditions. Nevertheless, when Groves—as the new officer in charge of the project—personally inspected the East Fork Valley section of the Tennessee site in late September, he shifted his position to concur with Marshall's view "that primitive housing could not be expected to meet family requirements of the class of personnel to be employed on this particular project." [5]

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[3] MDH, Bk. 1, Vol. 12, "Clinton Engineer Works," pp. 1.4-1.5; Bk. 4, Vol. 5, "Construction," pp. 5.1-5.2; and Bk. 8, Vol. 1, "General," pp. 5.7-5.8, DASA. Groves, *Now It Can Be Told*, p. 424.

[4] Marshall Diary, 25 and 29 Jun, 14 and 24 Jul, 2 and 23-24 Sep 42, MDR; DSM Chronology, 25 Jun 42, Sec. 2(e), 29 Jun 42, Sec. 15, 24 Jul and 2 Sep 42, each Sec. 9, OROO; Completion Rpt, Stone and Webster, sub: Clinton Engr Works, Contract W-7401-eng-13, 1946, pp. 12-14, OROO; Groves, *Now It Can Be Told*, pp. 25-26. See Ch. 3 for a more detailed discussion of the selection of the Tennessee site.

General Groves's approval of East Fork Valley cleared the way for development of the atomic community. In early October, Stone and Webster construction crews started work on the first phase. Bulldozers and graders cleared away existing structures, grubbed out trees and shrubs from the slopes of Black Oak Ridge, laid out rights of way for roads, and provided for a drainage system. At the same time, Captain Johnson conferred with the Corps' Construction Division housing specialists, seeking data on designs appropriate for the Tennessee site; Colonel Marshall visited the Ocala village, coming away convinced that its buildings, "with slight modification, would be ideal types for our village at Clinton"; and Stone and Webster worked closely with the Boston Area Engineers Office to complete the general layout plans for the village.[6]

Stone and Webster submitted its general plan for the atomic community to the Manhattan area office on 26 October. What had begun as a projected village of five thousand people emerged as the blueprint for a town of some thirteen thousand. Consistent with the Manhattan objective that townsite construction remain secondary to plant construction, general design specifications were based on utility, on minimizing costs, and on maximizing use of noncritical materials. Housing and other community facilities had only to furnish sufficient accommodations and services so that the majority of project workers would live on the reservation. Employees who did not have to commute daily to off-site communities would perform more efficiently in plant construction and operations and would be much less of a risk to the security of the project.[7]

Under terms of the Army's original contract, Stone and Webster was responsible for preparing detailed blueprints of not only the atomic community but also the large-scale electromagnetic plant. By November, however, as the vast scope of plant design became apparent, Manhattan realized that Stone and Webster simply did not have enough design personnel to execute both facets and meet the project's stringent time limits as well. So on the twenty-first it relieved Stone and Webster of town design functions, leaving the firm with responsibility for overseeing construction, operating utilities, and maintaining the roads of the town. To replace Stone and Webster in town design, Manhattan in early 1943 negotiated contracts with the John B. Pierce Foundation of New York, nationally known for its work on low-cost housing projects, and with Skidmore, Owings and Merrill of Chicago, a leading architectural firm. The two organizations were to function as a team, with the Pierce Foundation, which was primarily a research group, providing advice and plans on village housing and with Skidmore, Owings and Merrill furnishing architect-engineer services.[8]

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[5] Quotation from Marshall Diary, 24 Sep 42, MDR. See also ibid., 30 Jun, 24 Jul, 2 Sep 42, MDR, and DSM Chronology, 30 Jun and 24 Jul 42, each Sec. 9, and 2 Sep 42, Sec. 25, OROO.

[6] Marshall Diary, 7 Oct 42, MDR.

[7] MDH, Bk. 1, Vol. 12, pp. 2.9, 4.1, 4.4–4.5, DASA; Marshall Diary, 1 and 17 Oct 42, MDR; DSM Chronology, 1 and 7 Oct 42, each Sec. 9, and 17 Oct 42, Sec. 16, OROO; Groves, *Now It Can Be Told*, p. 425.

Following the engagement of Skidmore, Owings and Merrill and the Pierce Foundation, Colonel Marshall established a new administrative unit—the Town Management Division—to monitor the work of these two contractors. This division, however, was abolished in a major reorganization of the District in April, at which time the district engineer decided to separate the division's town planning and management functions. Two elements replaced the division, a Central Facilities Planning Unit and a Central Facilities Operating Division. The function of the Planning Unit was to coordinate the design work of Skidmore, Owings and Merrill with Stone and Webster construction activities at the townsite, whereas the function of the Operating Division was to provide management continuity to a developing community. Marshall also assigned two officers on his staff special responsibilities for community matters—Capt. Samuel S. Baxter for town planning and 1st Lt. Paul E. O'Meara for town management.[9]

Initial townsite construction was in the section of Oak Ridge eventually known as East Town, completed in early 1944. Centered on an administration building, located just south of Tennessee 61 and about 3 miles southwest of the Elza entrance to the Tennessee site, the East Town community comprised more than three thousand family-type housing units. Adjacent to the administration building was a town center of stores, service and recreation buildings, a guesthouse, several men's and women's dormitories, cafeterias, and a hospital. Overhead electrical and telephone lines and a sewer and water system built along main street, paralleling

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[8] Completion Rpts, Stone and Webster, sub: CEW, p. 14, and Skidmore, Owings and Merrill, sub: Portion of Townsite Planning of Oak Ridge, Contract W-7401-eng-69, 9 Sep 44, p. I.1, OROO; Ltr, Dist Engr to Stone and Webster, sub: Scope of Work at CEW, 21 Nov 42, OROO; DSM Chronology, 5 and 25 Nov 42, each Sec. 25, and 9 Dec 42, Sec. 4, OROO; MDH, Bk. 1, Vol. 12, pp. 2.9 and 4.5–4.7, DASA.

[9] MDH, Bk. 1, Vol. 12, pp. 3.5–3.7, 5.6–5.9, Apps. C17 (Chart, Central Facilities Org, Mar 43) and C21 (Chart, MD Org, dated 1 Apr 43 but effective 1 May), DASA; Memo, Blair to Marshall, sub: Proposed Org for Maint and Opn of Gen Facilities, 22 Jan 43, and attached organization chart, OROO; Completion Rpt, Du Pont, sub: Clinton Engr Works, TNX Area, Contract W-7412-eng-23, 1 Apr 44, following p. 17 (Chart, Clinton Area Engrs Office Org, 31 Mar 43), OROO.

Tennessee 61 and the house-lined residential streets, provided East Towners with complete public utility services.[10]

Construction of the East Town section of Oak Ridge established the pattern for subsequent expansions in the atomic community at the Tennessee site. As in virtually every other aspect of project construction, the primary emphasis was on speed. This was particularly true with housing, because throughout the wartime period there was never enough of it. The two most important obstacles to speedy construction were shortages of building materials and construction workers, and District and contractor officials devoted much effort to trying to overcome these problems. Building plans, wherever feasible, specified employment of available substitute materials, such as the use of fiber or gypsum board instead of wood for walls and cement blocks instead of poured concrete for foundations. Building designs emphasized standardization and simplicity of construction. When experience demonstrated that trailers and prefabricated hutments, both in reasonably good supply, would suffice as homes for most plant workers, town designers substituted them in later expansions. With District approval, Stone and Webster let out many lump-sum subcontracts for much of the town construction. Not only did these subcontractors speed up construction, they also furnished many additional employees who otherwise would not have been available for the project.[11]

Concurrently with construction of East Town, Stone and Webster built a separate self-contained community designated East Village, adjacent to Tennessee 61 east of the center of Oak Ridge near the Elza gate. Completed in late 1943 to house black workers, this community comprised fifty permanent family dwellings, four dormitories, a cafeteria, and a church. Black workers and their families never took up residence in East Village because of a pressing need of more housing for white employees. Black families were housed elsewhere in segregated hutment areas in Oak Ridge and in the vicinity of the gaseous diffusion plant.[12]

Second Phase, 1943–1945

The second phase of the Oak Ridge community development program, which began in the fall of 1943 and continued until late summer of 1944, grew out of Manhattan's need to provide additional housing and support services for a much larger population; the original estimate of thirteen thousand had more than tripled to a new high of forty-two thousand. Skidmore, Owings and Merrill again provided the principal architect-engineer services, establishing a field office where personnel worked with Captain

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[10] Completion Rpt, Stone and Webster, sub: CEW, pp. 13–15, OROO; MDH, Bk. 1, Vol. 12, pp. 2.9, 4.2, 4.5, DASA; Robinson, *Oak Ridge Story*, pp. 48–49. For the layout of East Town see architectural maps in Completion Rpt, Skidmore, Owings and Merrill, sub: Portion of Townsite Planning of Oak Ridge, pp. I.8–I.10, OROO, and aerial photographs in Robinson, *Oak Ridge Story*, following p. 56.

[11] MDH, Bk. 1, Vol. 12, pp. 5.2–5.5, DASA; Completion Rpt, Stone and Webster, sub: CEW, pp. 30–44, OROO; DSM Chronology, 25 Nov 42, Sec. 25, OROO.

[12] Completion Rpt, Skidmore, Owings and Merrill, sub: Portion of Townsite Planning of Oak Ridge, p. II.1, OROO; MDH, Bk. 1, Vol. 12, pp. 4.2–4.3, 7.8–7.9, 7.20, DASA.

OAK RIDGE SHOPPING MALL *(foreground)* AND DISTRICT HEADQUARTERS *(background)*

Baxter. Stone and Webster oversaw the construction, most of it contracted out to other building firms, notably John A. Johnson, Foster and Creighton, A. Farnell Blair, O'Driscoll and Grove, and Clinton Home Building, and to manufacturers of trailers and prefabricated houses, including Schult Trailers, Alma Trailers, National Homes, Gunnison Housing, and E. L. Bruce.[13]

To keep pace with the increasing requirements of the growing community of Oak Ridge, the District reorganized and greatly expanded its central facilities administration. Effective 1 November, Colonel Nichols established the CEW Central Facilities Division under the direction of Lt. Col. Thomas T. Crenshaw. To facilitate the construction and operation of the new community, Crenshaw set up within the division six specialized branches: town planning, town management, recreation and welfare, utility maintenance, engineering, and central facilities construction. The Town Planning Branch, directed by Captain Baxter, coordinated the work of the architect-engineer and construction contractors and assisted in formulating plans for new additions to the community. The Town Management Branch, headed by Captain O'Meara, had responsibility for forming an organization to manage the community; its five sections dealt with such matters as liaison with federal agencies, commercial concessions, public

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[13] Robinson, *Oak Ridge Story*, pp. 48–49; Marsden Diary, 13 Sep 43, OROO; MDH, Bk. 1, Vol. 12, pp. 4.2–4.3, 4.6–4.7, 5.2–5.3, 7.10–7.14, App. C5, DASA; Completion Rpts, Skidmore, Owings and Merrill, sub: Portion of Townsite Planning of Oak Ridge, pp. 1.1-1.3, and Stone and Webster, sub: CEW, pp. 14 and 103–26, OROO; Dist Engr, Monthy Rpt on DSM Proj, Sep 43, OCG Files, Gen Corresp, MP Files, Fldr 28, Tab A, MDR.

BLACK WORKERS AT CEW

health, and operation of dormitories and a guesthouse. The Recreation and Welfare Branch, under Capt. Thomas W. Taylor, oversaw the construction and operation of theaters, playing fields, and other recreational facilities in Oak Ridge. The Utility Maintenance Branch, headed by Maj. Melvin O. Swanson, oversaw the broader aspects of ensuring the efficient operation of the town's electrical and communications facilities. The Engineering Branch, directed by Maj. Paul F. Rossell, monitored the public services required by the community on a continuing basis; its eight sections handled transportation, mechanical repairs, water and sewerage, electrical and telephone service, and related activities. Finally, the Central Facilities Construction Branch, under Capt. Edward J. Bloch, monitored community development through seven sections; five oversaw the construction of dwellings and other structures (stores, schools, and churches), while two supervised the installation of utilities and the building of roads.[14]

For the second phase of community development, Skidmore, Owings and Merrill's original plans called for 9,250 more family units and enough additional dormitories to house seventy-six hundred persons. Reviewing this proposal in November, Manhattan accepted the figures for dormitory space but decided 6,000 family units would suffice for construction on available sites in East Town and East Village and in an undeveloped area along Tennessee 61, about 2 miles west of East Town. Only some 4,800 of the planned 6,000 family units were built before completion of second-phase construction. The new housing included many prefabricated units, based upon a design used successfully by the TVA, and some demountable types procured from other government projects in Indiana and West Virginia. Both met project requirements and were easily removable. The second-phase program also produced more than 50 new dormitories, with a total capacity of seventy-five hundred, and a number of prefabricated barracks to house the rapidly increasing military population. Stone and Webster also supervised construction of the additional cafeterias, shopping centers, schools, laundries, utilities, and other facilities required for the expanding population of Oak Ridge.[15]

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[14] Org Charts, U.S. Engrs Office, MD, 1 Nov 43, 15 Feb and 1 Jun 44, Admin Files, Gen Corresp, 020 (MED-Org), MDR; MDH, Bk. 1, Vol. 12, pp. 3.5–3.7 and 5.6–5.9, DASA; Dist Engr, Monthly Rpt on DSM Proj, Jul 44, MDR.

Third Phase, 1945

By late 1944, employment figures were again outstripping all earlier estimates. On the basis that at least a part of the increase was temporary and would decline as production plants were built, District and contractor officials at first agreed to try to cope with the new demand by maximum utilization of available housing. But further expansion of both the electromagnetic and diffusion plants rendered this expedient infeasible. By early 1945, with new estimates projecting the ultimate resident population of Oak Ridge at sixty-six thousand, Manhattan had no alternative but to undertake a third phase of community development.[16]

This new phase of community expansion added some 1,300 family units, 20 dormitories, about 750 trailers, as well as the necessary commercial and service facilities. Again emphasis was on demountable housing. Skidmore, Owings and Merrill served not only as architect-engineer but also as inspector of completed construction for the government, replacing Stone and Webster in this function, and the CEW Central Facilities Division directly oversaw third-phase construction carried out by various subcontractors.[17]

With completion of the third phase in the summer of 1945, the Clinton site had community facilities that more than adequately met the needs of the resident population in the town of Oak Ridge (sixty-one thousand) and in the nearby temporary construction camps (fourteen thousand). These facilities included 10,000 family units, 4,000 trailers, 3,000 hutments, 89 dormitories, and a variety of other types of units in lesser quan-

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[15] Completion Rpts, Skidmore, Owings and Merrill, sub: Portion of Townsite Planning of Oak Ridge, pp. 1.3–1.7 and 1.8–1.10 (architect's maps of Oak Ridge), and Stone and Webster, sub: CEW, pp. 13–18 and 72–84, OROO; Dist Engr, Monthly Rpt on DSM Proj, Sep and Nov 43, MDR.

[16] MDH, Bk. 1, Vol. 12, pp. 1.1–1.6 and 4.3–4.4, DASA; Completion Rpt, Stone and Webster, sub: CEW, pp. 13–15, OROO; Dist Engr, Monthly Rpt on DSM Proj, Jun 44, MDR; Robinson, *Oak Ridge Story*, pp. 48–49.

[17] MDH, Bk. 1, Vol. 12, pp. 1.3–1.4, 4.3–4.4, 5.1–5.3, DASA; Groves, *Now It Can Be Told*, p. 425; MPC Min, 22–23 Jan 44, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR.

PREFABRICATED HOUSES (*foreground*) AND APARTMENT DWELLINGS (*center*) AT CEW

tities. Total cost of the three-phase community development program was more than $100 million, over half for housing and the rest for support facilities.[18]

The Construction Camps

Manhattan made other provisions to accommodate its plant construction workers, because the major portion of the permanent housing facilities being built was intended for plant-operating personnel. As the construction workers would have only a temporary connection with the project, the Army initially planned for them to live off the atomic reservation and to commute to their jobs. But both District officials and construction contractors recognized early that the local economy, already strained with an influx of workers for other nearby war plants, would not be able to absorb the new wave of Manhattan workers. Furthermore, the deplorable condition of many local roads, the distance from the site of towns where housing was available, and the shortage of adequate transportation made commuting time-consuming and difficult. Accordingly, most Manhattan contracts

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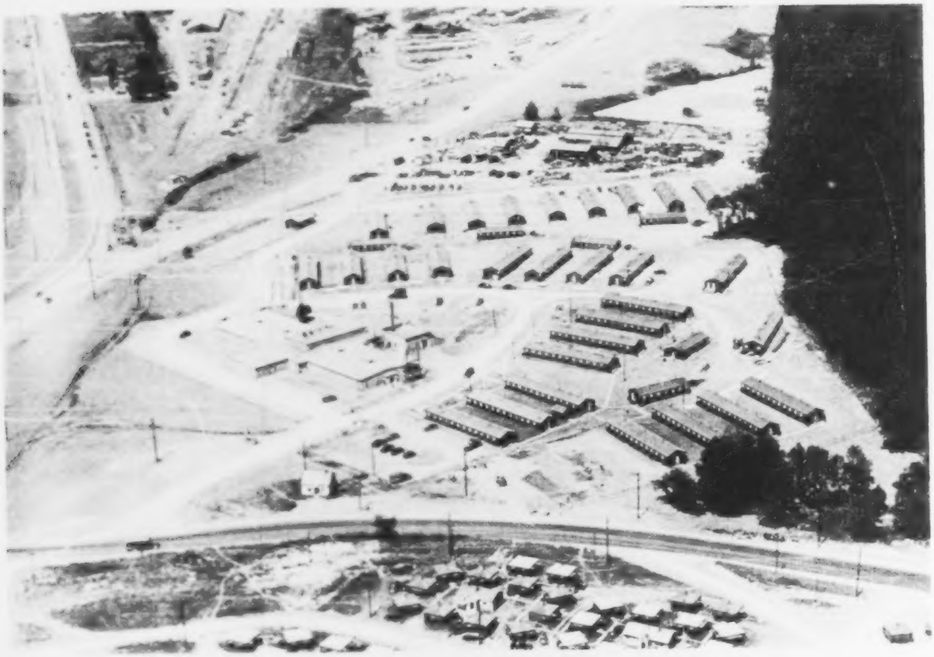
[18] MDH, Bk. 1, Vol. 12, pp. 1.3-1.4, 5.3-5.6, Apps. C1 (Chart, CEW Population), C3b, and C4, and Bk. 2, Vol. 4, "Construction," pp. 3.61-3.62, DASA; Robinson, *Oak Ridge Story*, p. 49. For a detailed account of the provision of community services see MDH, Bk. 1, Vol. 12, Secs. 8-17 and Apps. B6-B11 and B13-B14, DASA.



ENLISTED MEN'S BARRACKS AT CEW

provided that, where necessary, the major construction contractors would furnish temporary housing for their employees in on-site construction camps.[19]

Housing in the construction camps usually consisted of five-man prefabricated hutments (a type used with great success on other wartime construction projects), house trailers, and, in a few instances, dormitory-type structures. Surplus hutments and trailers were available at locations near the Tennessee site. Contractors had only to arrange for transportation to the site, where, with the addition of a few hastily erected buildings to house essential community services, they sufficed to meet the minimum needs of construction workers.

During late 1943 and early 1944, Stone and Webster and its subcontractors established a number of hutment camps and seven trailer camps in the vicinity of the Oak Ridge townsite. Skidmore, Owings and Merrill helped design the largest of Stone and Webster's trailer camps in Gamble Valley, south and west of Oak Ridge, which had more than four thousand spaces, with sections for both white and black workers. Du Pont housed some of its construction employees working on the plutonium

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[19] For a detailed analysis of the type of problems a contractor faced in providing adequate living facilities for its construction employees at the Tennessee site see Completion Rpt, Du Pont, sub: CEW, TNX Area, pp. 160–70, OROO.

GAMBLE VALLEY TRAILER CAMP AT CEW

semiworks in Stone and Webster hutments and others in an existing school building, remodeled to serve as a dormitory.

Contractors established four more camps for thousands of diffusion workers at the confluence of Poplar Creek and the Clinch River, about 15 miles southwest of Oak Ridge. In June 1943, the J. A. Jones Construction Company began building hutments in the Happy Valley area, directly southeast of the gaseous diffusion plant, to house the first of some fifteen thousand workers. Later trailers, dormitories, and so-called Victory Houses supplemented the hutments and cafeterias; a shopping center and a school supplied essential community services. An overflow of diffusion workers occupied two smaller camps directly west of Happy Valley. And when Ford, Bacon, and Davis began construction on the plant-conditioning area in 1944, the contractor built a separate camp for its workers a short distance east of the plant site. After the peak of construction had passed, population of the camps declined, but they continued to be partially occupied for many months after the war was over.[20]

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[20] MDH, Bk. 1, Vol. 12, pp. 7.7–7.9; Bk. 2, Vol. 4, pp. 3.61–3.66 and App. B3 (Gen Layout of K-25 Plant, including K-27); and Bk. 5, Vol. 5, "Construction," p. 5.3, DASA. Dist Engr, Monthly Rpts on DSM Proj, Mar–May 43, MDR. Completion Rpts, Stone and Webster, sub: CEW, p. 17; Skidmore, Owings and Merrill, sub: Portion of Townsite Planning of Oak Ridge, p. II.12; Du Pont, sub: CEW, TNX Area, p. 160, and M. W. Kellogg Co. and Kellex Corp., sub: K–25 Plant, Contract W–7405–eng-23, 31 Oct 45, Sec. I, pp. 31–32 and map of K–25 area and aerial photograph of labor camps following p. 40, OROO.

Community Management

Manhattan's community management program aimed to maintain adequate community facilities but with a maximum economy of manpower and materials and minimum risk to project security. To attain these objectives, the District's town management staff instituted and experimented with a variety of specific measures. For example, it turned over to the professional employees of civilian contractors the detailed administration of community operations; it subsidized dormitory rents and bus fares; and it secured assistance from existing outside civilian organizations, such as the American Red Cross, the TVA, and certain governmental agencies of the state of Tennessee. The test for all such measures was the extent to which they contributed to the principal objective of the Tennessee site: production of sufficient fissionable materials in time to fulfill the demands of the bomb development program at Los Alamos.[21]

To the casual visitor driving down Tennessee 61 from the Elza gate in the spring of 1943, the rapidly growing clusters of buildings on the slopes of Black Oak Ridge gave every appearance of being an already thriving village of some size. On closer examination, however, the visitor would have found that most of the houses were unfinished, the shopping centers still under construction, and utilities not yet operating. For Oak Ridge did not begin to function as an organized community until the summer of 1943, when the first families began to move in and some of the commercial and service facilities opened their doors for business. In fact, the town had no name until Marshall's executive officer, Lt. Col. Robert C. Blair, requested employee suggestions. District officials finally chose "Oak Ridge," appropriate because of the location and because "its rural connotation held outside curiosity to a minimum."[22]

With the opening of the first cafeteria and dormitories in East Town in mid-June, the Central Facilities Operating Division—with Captain Baxter serving for a time as town manager—began active management of the community. But direct administration of the community by the Army lasted only a few months. The Army had never been enthusiastic about having District military personnel directly involved in the time-consuming day-to-day administration of Oak Ridge. Groves and Nichols concluded that direct military operation of the town would require not only a large military staff but also much of the time and energy of the district engineer himself.[23]

The September 1943 decision to further enlarge the town of Oak Ridge precipitated a search for a civilian organization to manage it. Stone and Webster and J. A. Jones were likely candidates, but a study showed that those firms had fully committed most of their available supervisory personnel to overseeing construction

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[21] MDH, Bk. 1, Vol. 12, pp. 6.1-6.2, 7.14-7.23, 9.1-9.2, 11.1-11.9, 18.11-18.12, DASA; Groves, *Now It Can Be Told*, pp. 425-26.

[22] Quotation from Robinson, *Oak Ridge Story*, p. 50. See also Groves, *Now It Can Be Told*, pp. 425-26; MDH, Bk. 1, Vol. 12, p. 5.6, DASA.

[23] MDH, Bk. 1, Vol. 12, p. 5.8 and App. C21, DASA; Org Chart, U S. Engrs Office, MD, 15 Aug 43, MDR.

OAK RIDGE ELEMENTARY SCHOOL

of the electromagnetic and diffusion plants. So Manhattan decided to approach the Turner Construction Company of New York. Groves knew that the company had established a fine record on other important war projects, and Nichols recently had worked closely with Turner officials in his capacity as area engineer in charge of construction of the Rome (New York) Air Depot.[24]

By mid-month, Manhattan and Turner representatives reached an agreement that the company would establish a wholly owned but completely separate organization—designated the Roane-Anderson Company, after the two Tennessee counties in which the atomic site was located—to administer the town under a cost-plus-fixed-fee contract. According to its provisions, Roane-Anderson would manage, operate, and maintain the government-owned facilities and services at the Clinton reservation, exclusive of restricted plant areas. For this service the company was to receive a fee of $25,000 a month, or slightly less than 1 percent of $2.8 million—the estimated total monthly cost of operating the facilities. The terms of the final contract were sufficiently flexible to permit Manhattan to assign a broad range of facilities and activities to the company's administration. Faced with the unexpectedly rapid growth of Oak Ridge, which brought an immediate need for a multiplicity of new community services, District authorities found a ready and effec-

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[24] MDH, Bk. 1, Vol. 12, pp. 6.3–6.4, DASA; Groves, *Now It Can Be Told*, p. 425; Cullum, *Biographical Register*, 9:593; Marshall Diary, 18 Jun 42, MDR.

CENTER THEATRE
UNITED STAT POST OFFICE

MAIN POST OFFICE AND THEATER IN OAK RIDGE

tive solution in a policy of "give it to Roane-Anderson."[25]

Roane-Anderson gradually took over responsibility for administration of most community functions from the Town Management Branch of the CEW Central Facilities Division. In certain respects its role was comparable to that of the municipal administration of a civilian community, but there were also some major differences. It provided Oak Ridgers with the usual publicly owned utilities and also with steam heat and telegraph service. It paid the policemen, firemen, and medical personnel, but the District retained administrative control of the police, fire departments, and hospital. The company provided physical maintenance for the schools, but the District delegated their actual operation to Anderson County educational officials. In recreation, Roane-Anderson had no part at all. Instead, the District, in July 1943, permitted organization of a Recreation and Welfare Association, comprised of residents of the community, to operate theaters, bowling alleys, athletic fields, taverns, library services, and a weekly newspaper.[26]

Where Roane-Anderson's role differed most greatly from that of an ordinary municipality was in its assumption of many of the activities normally carried out by private enterprise in American society. Thus, the company managed and maintained virtually all of the real estate of the community—housing of all kinds, farmlands (some of which it actually cultivated), forested areas, public grounds, and some fifty-four private cemeteries. It operated cafeterias (there were twenty at the period of peak employment in May 1945), laundry and dry cleaning establishments, and cold storage and warehouse facilities. It delivered coal, fuel oil, and wood to community residents in winter and ice in summer. A company concessions department rented space and granted licenses to private enterprise for grocery, drug, and department stores; clothing, shoe repair, and barber shops; and garages, service stations, and other commercial establishments in the town centers and neighborhood shopping areas. It operated a transportation system that included both on-site and off-site bus service, the 35-mile CEW Railroad, and the CEW Motor Pool.[27]

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[25] Roane-Anderson Hist, Contract W-7401-eng-115, 30 Nov 51, pp. 1 and 5 (source of quotation), OROO. See also MDH, Bk. 1, Vol. 12, p. 6.4, DASA. The Roane-Anderson contract was formally signed on 14 Feb 44, effective 15 Sep 43.

[26] Roane-Anderson Hist, pp. 23-62, OROO; MDH, Bk. 1, Vol. 12, pp. 6.5, 6.7, 9.1, 10.1, 11.2, DASA.

By February 1945, Roane-Anderson had more than ten thousand employees, recruited from among people living both on and off the reservation. From the start, the Army viewed direct operation of so many functions by a single contractor as a temporary arrangement. Consequently, when community growth began to level off, it assisted Roane-Anderson in transferring many community activities to more efficient specialized operators. By granting concessions, letting subcontracts, returning certain operations to District control, and terminating activities, the company reduced its direct employment to about five thousand by August 1945. Among the major activities given up by Roane-Anderson were bus operations (taken over by the American Industrial Transit, Inc.), most housing operations, trash and garbage collection, and distribution of ice, fuel, oil, and coal.[28]

Through the CEW Central Facilities Division, the Army exercised close supervision over Roane-Anderson and the various community subcontractors and concessionaires. Beginning in the fall of 1943, several reorganizations of that division were at least partially designed to realign its various administrative sections so that they would reflect the shift from community construction to operations and more nearly complement those of the Roane-Anderson organization. These organizational changes culminated finally in November 1944 in establishment of a Roane-Anderson Branch within the division. Through administrative service, maintenance, utilities, transportation, and operations sections, this branch supervised counterpart sections, in the company's community management organization. The chief of the branch, Maj. Henry G. Hoberg, shared executive direction of the community with Roane-Anderson's project manager, Clinton N. Hernandez. In addition, a Central Facilities Advisory Committee, comprised of representatives of all the major contractors (including Roane-Anderson), assisted the division chief in coordinating community operations.[29]

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[27] Roane-Anderson Hist, pp. 23–62, OROO.

[28] Ibid., pp. 4–5, 22–63, App. F (Graphic Rec of Roane-Anderson), OROO; MDH, Bk. 1, Vol. 12, p. 1.5, DASA.

[29] Org Charts, U.S. Engrs Office, MD, Nov 43

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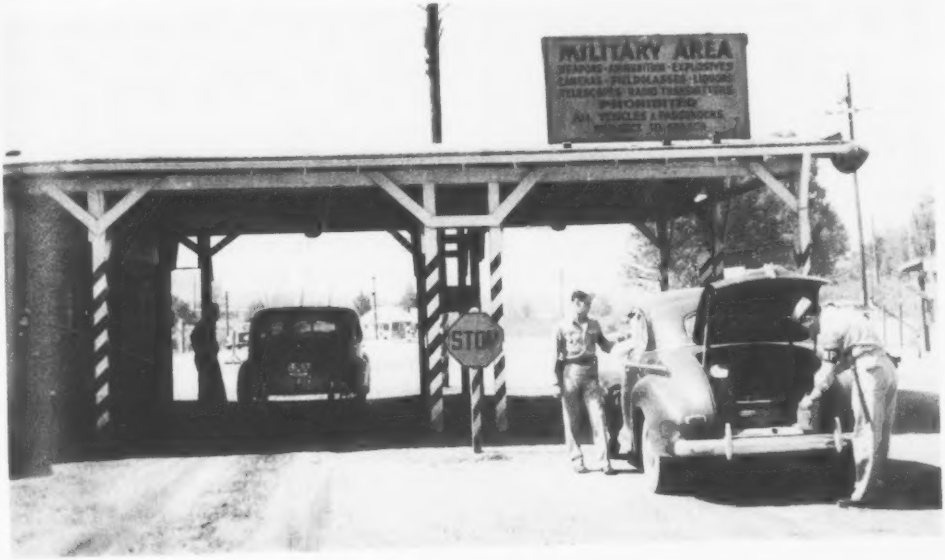

CEW RESERVATION ENTRY POINT

Limited reorganizations in 1945 did not change the basic relationship between the CEW Central Facilities Division and Roane-Anderson. In January, the district engineer transferred some of this staff's functions—safety, special services (chiefly recreational activities), and public relations—to Lt. Col. John S. Hodgson, who had succeeded Colonel Crenshaw as division chief in May 1944, and, at the same time, changed Hodgson's title to executive assistant (to the district engineer) for operations. Roane-Anderson also made some changes in its organization to adjust to its divestiture of certain major activities.[30]

The average civilian resident of Oak Ridge had most of the essential community facilities and services that would have been available in other comparable wartime communities. What he chiefly lost as long as he resided on the Clinton reservation were some of his civic rights. The War Department had declared the Tennessee site a closed military reservation effective 1 April 1943, with strict control of entry, guards at the gates, fences at strategic points, and mounted patrolmen regularly checking unfenced sections of its boundaries. The Army did not permit residents to establish and participate in normal municipal and township governments, although it did allow them to form certain social welfare organizations.[31]

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and 15 Feb, 1 Jun, 28 Aug, 10 Nov 44, MDR; Roane-Anderson Hist, Apps. E1-E4 (Org Charts, 20 Apr, 1 Sep, and 1 Nov 44), OROO; MDH, Bk. 1, Vol. 12, p. 3.8 and App. C18 (Chart, Central Facilities Org, Mar 44), DASA.

[30] Org Chart, U.S. Engrs Office, MD, 26 Jan 45, MDR; Roane-Anderson Hist, App. E5 (Org Chart, 6 Feb 45), OROO; MDH, Bk. 1, Vol. 12, App. C19 (Chart, Central Facilities Org, Mar 45), DASA.

[31] MDH, Bk. 1, Vol. 12, pp. 1.5-1.6, DASA. See also WD Cir 57, 20 Feb 43, Sec. 3.

CHAPEL-ON-THE-HILL IN OAK RIDGE

But residents were not entirely without state and local civic rights. The legislature of Tennessee, concerned over the loss of state lands and taxes in earlier large cessions to the federal government, declined the War Department's request in early 1943 to cede sovereignty over the Tennessee site: Oak Ridge's legal status was that of a federal area, not a federal reservation. Hence, its residents legally were citizens of either Roane or Anderson County and of the state of Tennessee, subject to their criminal and civil laws and entitled to the civic privileges of those jurisdictions. They could, for example, vote in state and county elections. If they violated the law, they were subject to arrest by Oak Ridge policemen, deputized by the sheriff of Anderson County, and trial in local or state courts. The schools for their children, too, remained legally a part of the Anderson County system, although they were built and operated largely with federal funds. Because the District, for reasons of security, limited school attendance to the children of residents, the attorney general of Tennessee ruled that the schools were nonpublic and therefore not eligible for state aid.[32]

Residing in the atomic communities in Tennessee during the war years was in many respects similar to living in frontier settlements or boomtowns: mud in winter and dust in summer; houses partially built and incompletely furnished; the stores with essential items missing from their shelves; overcrowded schools, churches, and theaters; inadequate recreational activities, at least in the early months; and countless other deficiencies associated with communities that have grown too fast. Nevertheless, many Oak Ridgers would later recall with pleasure the prevailing sense of camaraderie and democracy among residents drawn from all walks of life—Nobel Prize–winning scientists, corporate executives, plant managers, skilled workers, officers and enlisted servicemen, manual laborers, and housewives—as they shared together the many hardships of life and worked together to solve the problems of day-to-day living under difficult circumstances. And for many residents, the excitement and satisfaction of being part of a great and unique enterprise that might well prove to be the key to winning the war sufficed to more than compensate for the many drawbacks.[33]

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[32] MDH, Bk. 1, Vol. 12, pp. 9.1–9.9 and 11.1–11.13, DASA; Robinson, *Oak Ridge Story*, pp. 60–61 and 63–64; Completion Rpt, Skidmore, Owings and Merrill, sub: Portion of Townsite Planning of Oak Ridge, pp. V.1–V.3, OROO.

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[33] Robinson, *Oak Ridge Story*, pp. 46–47 and 51–61; Compton, *Atomic Quest*, pp. 158–60.

CHAPTER XXII

The Atomic Communities in Washington State

The atomic communities of the Hanford Engineer Works (HEW) in south central Washington State were in the vicinity of one of the great historical routes of immigration to the Northwest United States. In 1805 Lewis and Clark had covered a portion of the famed Oregon Trail as they made their way down the Snake River to the Columbia, and a generation later thousands of settlers had traversed it as they forged westward. Indian wars, however, delayed settlement in central and eastern Washington until the 1850's and, thereafter, the general aridity of the semidesert sagebrush country in the vicinity of the confluence of the Yakima and Columbia Rivers discouraged attempts at agriculture, except for some sheep raising. Finally, in the early 1900's, limited development of irrigation attracted a few farmers, who planted orchards and raised crops of mint and alfalfa. It was they who, in the early spring of 1943, suddenly faced displacement from their homes in three tiny rural hamlets—White Bluffs, Hanford, and Richland—to make way for thousands of construction and operating employees of the plutonium project. Events remote from the peaceful agriculture pursuits of these modern pioneers were to bring this hitherto bypassed region into the mainstream of American history.[1]

Selecting Sites

Faced with development of an area isolated from any sizable city, Du Pont and Army engineers began planning early for large on-site communities. Because of the omnipresence of radioactivity in the plutonium processes, they could not follow the normal practice of having construction and plant-operating employees live adjacent to the production plants. Scientists had indicated that it would not be safe for plant-operating employees to reside within 10 miles of the pile and separation production units. And because these units would have to be tested during the later phases of plant construction, even construction employees would have to live some distance from them.

Saving time was another urgent consideration in location planning.

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[1] *Dictionary of American History*, rev. ed., s.v. "Oregon Trail" by Robert Moulton Gatke; MDH, Bk. 4, Vol. 4, "Land Acquisition, Hanford Engineer Works," pp. 2.1–2.9, DASA; Du Pont Constr. Hist., Vol. 1, pp. 2–6, 8–9, and maps (pp. 3 and 5), HOO. See also Ch. IV.

Project engineers favored sites already occupied by rural villages, where they would be able to take advantage of existing grading, buildings, road networks, and utilities. To facilitate the selection process, they drew up three alternate site plans. The first proposed a combined construction and operating community at Benton City on the Yakima, a few miles west of Richland and about 24 air miles from the main process area. (*See Map 4.*) The second proposed three separate communities: Camp A, about 2.5 miles south of the existing village of Hanford; Camp B, about 2 miles north of Richland; and Camp C, in the hamlet of White Bluffs. Under this plan, when the time came for startup of the process plants, the three camps would be consolidated to form an operating village at the Camp A site. The third plan called for locating all construction and plant-operating employees at the Camp A site.[2]

After giving due consideration to each plan, Du Pont and Army engineers agreed to establish two separate communities: a construction camp at Hanford and an operating village at Richland. Reasons of safety and efficiency dictated that all construction employees should reside in a single community, and Hanford appeared best to meet such requirements. Its distance of about 6 miles from the nearest process areas was sufficient not only to ensure the workers' safety during startup testing but also to provide them easy access to all the major work sites. Its location at the intersection of the Connell-Yakima state highway and Pasco–White Bluffs road and on a branch line of the Chicago, Milwaukee, St. Paul and Pacific Railroad gave it the necessary road and rail access. Water was available from existing wells and the river and electricity from a Pacific Power and Light Company substation. The natural contour of the land at the village site made grading for construction unnecessary and simplified sewerage and drainage problems, and the existing buildings provided the temporary housing that would be needed by the first construction crews.[3]

Safety was the determining factor in the decision to locate the operating community at a separate site. Project engineers found that two locations—Benton City and Richland—both met the basic criteria: Each was about 25 miles from the production plant sites, and each had adequate road and rail access, a sufficient source of water and electricity, and a number of existing buildings. But Benton City had not been included in the original land acquisition and project officials believed that, for reasons of security, the operating village must be within the reservation. They could have taken steps to acquire the Benton City area, but serious opposition had arisen among local residents because of the extent of the government's original land acquisition. Seeking to avoid additional acquisitions likely to inflame public opinion, project community planners chose Richland as the site for the operating community.[4]

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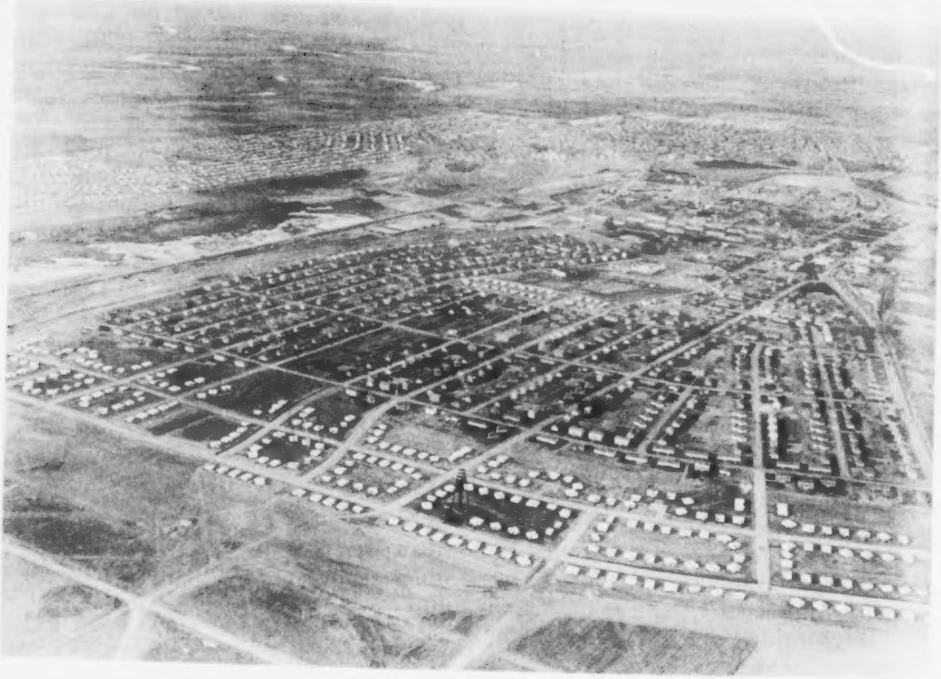
[2] MDH, Bk. 4, Vol. 5, "Construction," pp. 5.2–5.3 and App. D13 (Alternate Site Plans for Hanford Camp), DASA; Du Pont Constr Hist, Vol. 1, pp. 41–42, HOO.

[3] MDH, Bk. 4, Vol. 5, pp. 5.2–5.3, DASA; Matthias Diary, 25 Feb and 24–25 Mar 43, OROO; Du Pont Constr Hist, Vol. 1, pp. 9–10 and 42–43, and Vol. 2, pp. 348–49, HOO.

[4] MDH, Bk. 4, Vol. 3, "Design," pp. 8.1–8.2, DASA; Matthias Diary, 8 and 10 Mar 43, OROO; Du Pont Constr Hist, Vol. 1, p. 102, HOO. See also Ch. XV.



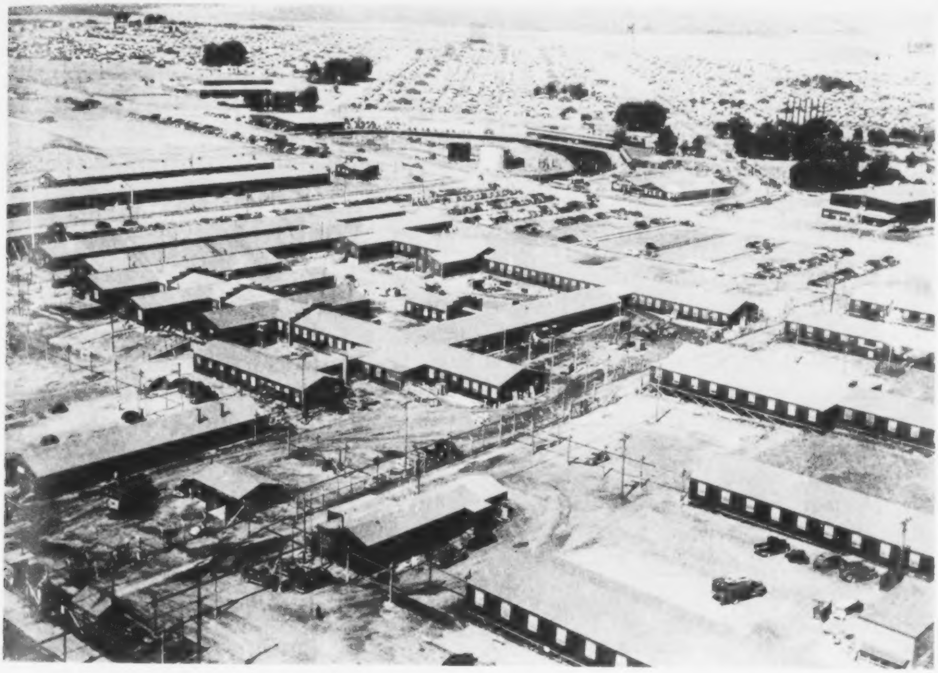
HANFORD CONSTRUCTION CAMP AT HEW. *Aerial view shows its vast size.*

Hanford: The Construction Camp

Once the planners had reached a final decision concerning location, Du Pont immediately began work on both the construction camp and the operating community, with Du Pont and Army personnel at the Hanford site and Wilmington headquarters working in close cooperation. Planning and design of the two communities proceeded more or less simultaneously in early 1943, but the construction camp which had to be ready for occupancy as soon as possible had first priority.

At the outset, Du Pont's construction camp planning and design efforts were handicapped by the tenuousness of essential quantitative data. Only indeterminate figures were available on how many workers were likely to reside in the camp, because the Metallurgical Laboratory–Du Pont design team had not progressed far enough with plans for the plutonium production facilities to provide an accurate estimate. A similar problem existed with figures on how many construction workers could live in off-site housing, because more urgent matters had delayed the Hanford area engineer, Lt. Col. Franklin T. Matthias, from making a survey of the Hanford area.

Lacking this statistical data, Du Pont had no choice but to go ahead with plans and designs on the basis of



CAMP ADMINISTRATIVE AREA (*foreground*) AND RESIDENTIAL AREA (*background*) AT HEW

hurriedly prepared estimates that projected a total construction work force of twenty-five thousand to twenty-eight thousand, half of whom, the company hoped, would live in off-site housing. To circumvent inevitable revisions, Du Pont developed a planning strategy of adopting easily expansible layouts and building designs and of learning the experience of other firms that had built construction camps in isolated, semiarid regions with adverse climatic conditions. This circumspect approach proved fortuitous, especially in view of subsequent developments that revealed earlier projections on the size of the construction force were grossly inaccurate (nearly twice as many workers would be required as originally estimated) and that very little off-site housing was available. Meanwhile, General Groves made a thorough inspection of the Washington site in March, after which he, Colonel Matthias, and other Army representatives sat down with Du Pont's field staff and worked out basic steps for getting construction started.[5]

Field work began at the Hanford campsite in early April. On the fourth, Du Pont and Hanford area office personnel—with plans in hand for the first barracks, mess hall, and service buildings in the construction camp—carried out a general reconnaissance of the area and reached agreement that work should begin immediately on facilities adequate to house and feed a starting work force of two thousand. They also agreed to proceed with orders for materials and equipment in quantities sufficient to provide units for four thousand workers and, at the same time, established a construction schedule looking to completion of the whole camp by 1 December. On 6 April, workers began erection of the first barracks.[6]

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[5] MDH, Bk. 4, Vol. 5, pp. 5.1–5.2, DASA; Rpt, sub: Investigations of Projs Having Similar Climatic Conditions, ca. 1943, HOO; Matthias Diary, 24–25 Mar 43, OROO; Groves Diary, 24–25 Mar 43, LRG.

Du Pont officials responsible for Hanford construction met biweekly (later weekly). They drew up procurement schedules for critical building materials, establishing a policy of keeping on order equipment for ten barracks and one mess hall to forestall the inevitable delays in delivery. In late July, Du Pont commissioned the architect-engineer firm of Jones, Couillan, Thery, and Sylliassen to review all plans for the campsite and assist in development of further layouts. The recommendations of the architect-engineer, combined with periodic subsequent studies of particular problems by Du Pont's field engineers, provided the basis for the further development and operation of the construction camp.[7]

In September, on the basis of the Metallurgical Laboratory-Du Pont design team's new report that construction of the plutonium production plants would require a considerably larger work force than previously anticipated, the Army and Du Pont moved to firmer ground in their projections of peak population requirements for Hanford. Actually, the peak of construction came in November, when for a period of more than a month some fifty-three hundred workers were employed in building the camp, including some diverted temporarily from the plant construction work force. But it was not until July 1944 that Du Pont announced that construction was 98 percent complete, with nearly twelve hundred new and remodeled buildings and sufficient support facilities to house, feed, and supply the daily necessities of the fifty-one thousand people who, by that time, were living at the construction camp.[8]

Completion of the camp facilities in time to meet the peak population requirements was possible only because of the close cooperation of the Hanford area engineer with Du Pont and its subcontractors in overcoming chronic labor shortages and procuring a variety of critical building materials. Du Pont benefited greatly from Manhattan's countrywide recruiting efforts in 1943 and 1944 and from the Army's approval of its use of subcontractors who had access to local labor. For example, the Walla Walla (Washington) firm of A. A. Durand

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[6] MDH, Bk. 4 Vol. 5, pp. 5.4–5.5 and 5.20–5.21, DASA; Du Pont Constr Hist, Vol. 2, p. 374, HOO.

[7] MDH, Bk. 4, Vol. 5, pp. 5.5–5.7 and 5.19, DASA; Rpt, Jones, Couillan, Thery, and Sylliassen (architect-engineer), sub: Housing and Traffic Analysis of the Hanford Camp Area, 17 Aug 43, HOO; Du Pont Constr Hist, Vol. 2, p. 382, HOO.

[8] MDH, Bk. 4, Vol. 5, pp. 5.21 and App. B19 (Hanford Camp Bldg Constr Dates), DASA; Dist Engr, Monthly Rpt on DSM Proj, Jun 44, OCG Files, Gen Corresp, MP Files, Fldr 28, Tab A, MDR; Du Pont Constr Hist, Vol. 2, pp. 351 and 380–83, HOO.

and Sons drilled wells and the Seattle firm of McManama and Company erected boilers. Matthias and his staff expedited procurement of many items in short supply, including Army tents, boilers, hot water heaters, toilet fixtures, fans, cooling and refrigeration units, heating coils, and mess hall equipment. Through Army channels the area engineer arranged for transfer from other government projects of many materials otherwise virtually unobtainable. The Army also actively supported Du Pont's various measures to shorten construction time and save materials, including employment of prefabrication and preassembly wherever feasible. An outstanding example was the decision by Groves and Du Pont to substitute prefabricated hutments for barracks.[9]

Because of the persistent problems of procuring and conserving an adequate construction work force at the Washington site, the Army stressed those aspects of the Hanford camp that would make living conditions more tolerable for the average employee. An example was its effort to ensure that Du Pont incorporate effective means for heating, cooling, and ventilating housing units and hutments—a very important consideration in view of area climatic conditions characterized by extremes in heat and cold, rapid changes in temperature, and occasional severe dust storms. The system eventually installed employed hot air heated by steam from a central plant. Although this method was more costly than having coal heaters in each individual housing unit or hutment, it provided a means for circulating air, cooled by water evaporation, in the hot summer months.[10]

Newly recruited workers found themselves in what must certainly have been one of the largest temporary communities ever erected. Hundreds of one-story structures, standing in evenly spaced rows along freshly graded streets, filled the generally flat terrain west of the broad Columbia River. The majority of these structures were housing units. At the center were row upon row of wing-type barracks. To the south were hundreds of much smaller hutments. On the north and west stood thousands of family-sized trailers, each positioned on its individual plot. Interspersed at conveniently located intervals were cafeteria buildings. In a triangular-shaped area near the river and between the barracks and the north trailer camp were most of the commercial and administrative buildings, some remodeled from existing structures. Here also were many of the community and recreational facilities—a theater, church, school, hospital, library, and an auditorium-gymnasium. Rising here and there above the low level of most structures were the smoke stacks of heating plants, water

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[9] MDH, Bk. 4, Vol. 5, p. 5.18–5.21 and Apps. B4 (Summary of Subcontracts), B23 (Hanford Camp Subcontracts), and B24 (Completion Forecast–Hanford Camp), DASA; Matthias Diary, Apr 43–Jul 44 (see entries of 22 Apr, 18 May, and 11 Jun 43), OROO; Ms, Hageman, "Hanford: Threshold of an Era," 1946, p. 71, Admin Files, Gen Corresp, 461 (Hanford), MDR; Du Pont Constr Hist, Vol. 1, pp. 51–68, 218–35, 282–323, HOO.

[10] Matthias Diary, 6, 8, and 15 Apr 43, OROO. For a vivid description of the periodic dust storms that occurred at the Hanford camp see Ted Van Arsdol, *Hanford: The Big Secret* (Richland, Wash.: *Columbia Basin News*, 1958), pp 50–51. Du Pont Constr Hist, Vol. 1, pp. 87–91, HOO.

RICHLAND VILLAGE AT HEW. *Aerial view shows the commercial center (foreground), buildings of the administrative headquarters (middle ground), and the residential area (background).*

and oil storage tanks, and a few trees. Utility lines strung on tall poles lined every street, seeming to bind together the scattered segments of the Hanford camp.[11]

Richland: The Operating Community

Richland, with a population of 250, was in early 1943 the center of an agricultural community of some 600 persons who derived their livelihood from farming the irrigated bottomlands near the junction of the Yakima and Columbia Rivers. Most of the commercial and civic structures of the village and some of its homes were built along the axis of a state highway, providing a ready route of access eastward to the important communication centers of Kennewick and Pasco and northward to Hanford and White Bluffs. The original buildings of Richland were of substantial construction, many of them cement or brick. Community services included an underground water system (but no central sewerage system), electricity, and telephones. The roads were chiefly gravel or packed earth, but some had asphalt surfacing. Surrounding the village center were numerous small farms, planted with orchards or other irrigated corps.[12]

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[11] MDH, Bk. 4, Vol. 5, pp. 5.6–5.18 and App. A4 (Map, Hanford Camp Layout), DASA; Du Pont Constr Hist, Vol. 2, p. 386 and 392–512, HOO.

[12] MDH, Bk. 4, Vol. 3, pp. 8.2–8.3, DASA; Du Pont Constr Hist, Vol. 1, pp. 6 and 101–06, HOO.

As with the Hanford construction camp, the Army turned over to Du Pont the task of converting this farm community into suitable headquarters for the massive plutonium production project and a home for thousands of plant-operating employees. The Army's aim was to enable the prime contractor to achieve maximum operating efficiency in accomplishing its task by combining requirements and services needed for both the production plants and the village, and thus from the outset General Groves and Colonel Matthias emphasized the importance of making the most economic use of project resources. Illustrative of this policy was the size of permanent houses for the supervisory and technical operating personnel. Du Pont believed that such personnel would require at least three-bedroom homes, but the Army disagreed and assigned most of them only one- or two-bedroom homes. To ensure compliance with Army policy, the Hanford Area Engineers Office monitored all housing activities.[13]

Colonel Matthias had considerable authority as area engineer and utilized several channels to exercise direct control over design and construction of Richland. Through his legal officer, he reviewed and approved Du Pont's subcontracts and other legal arrangements relating to the building of the village. Through his construction chief's so-called Richland Division, he maintained a more specific check on construction activities. In addition, Matthias made frequent personal inspections of the village and conferred regularly with Du Pont headquarters officials and field representatives.[14]

With virtually all of its own design and engineering personnel committed to work on the production facilities or other wartime projects, Du Pont had few employees to spare for the village project. Hence, with permission of the Army, it opened negotiations with several architect-engineer firms in the Pacific Northwest. G. A. Pehrson of Spokane was the low bidder and, in mid-March, Du Pont signed a contract with the firm.[15]

Pehrson started work immediately on layout plans for the village community, using as a guide the Du Pont–Army population projections that assumed a 40- to 50-percent occupancy in off-site housing. Because these projections forecasted a population of 6,500 with possible expansion to 7,500, Pehrson drafted plans for 980 conventional family units of relatively permanent construction and also for a few dormitories to house single men and women. But Du Pont and Matthias soon discovered from incoming employees that suitable places to live in the surrounding communities were extremely scarce. Consequently, in June they revised initial estimates of Richland's ultimate population to 7,750 with potential growth to 12,000 and instructed Pehrson to increase the number of conventional family dwellings to 2,000. Pehrson had barely started on the expanded program when new calculations indicated the Richland population was likely to escalate to at least 16,000 (later revised to 17,500). Following consultation with Matthias, Du Pont directed Pehrson to add another 1,000 family units, bringing the total to 3,000.[16]

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[13] MDH, Bk. 4, Vol. 6, "Operations," p. 9.1, DASA; Ltr Contract W-7412-eng-1, 1 Dec 42 (accepted 21 Dec 42), OCG Files, Gen Corresp, Groves Files, Fldr 19, Tab B, MDR; Contract W-7412-eng-1 (Du Pont), 8 Nov 43, OROO; Matthias Diary, 2–3 Mar, 16–17 and 21 Apr, 20 May, 29 Nov 43 and 4 Jan 44, OROO. See also Ltr, H. T. Daniels (Design Proj Mgr, TNX Div, Du Pont) to Groves, sub: Proj 9536-Village, 25 Apr 43, and Msgs, Matthias to E. B. Yancey (Gen Mgr, Explosives Dept, Du Pont), 23 Apr 43, and Yancey to Matthias, 24 Apr 43; Ltr, Daniels to Groves, sub: Proj 9536-HEW and 1100 Area–Townsite, 28 Apr 43, and Msgs, Matthias to Yancey and Yancey to Matthias, both 26 Apr 43; Memo, Matthias to Groves, 4 Sep 43. All in Admin Files, Gen Corresp, 620 (Hanford), MDR.

[14] MDH, Bk. 4, Vol. 5, Apps B57–B58 (Org Charts, Hanford Area Engrs Office and Du Pont's HEW Field Proj), DASA; Du Pont Constr Hist, Vol. 1, pp. 23–139 (Org Charts, Hanford Area Engrs Office and Du Pont's HEW Field Proj), HOO; Matthias Diary, Feb 43–Dec 45, passim, OROO.

[15] MDH, Bk. 4, Vol. 3, pp. 8.4–8.5 and App. B4 (Summary of Subcontracts), DASA; Matthias Diary, 2, 5, 9, 12, 15, and 17 Mar 43, OROO; Dist Engr, Monthly Rpts on DSM Proj, Feb–Mar 43, MDR; Du Pont Constr Hist, Vol. 1, pp 106 and 285–86, HOO.

Faced with a vastly larger housing program than anticipated, Du Pont and Matthias began looking for ways to expedite development of the Richland community. Aware that General Groves had spoken quite enthusiastically of the advantages of portable prefabricated housing being installed at the Tennessee site, Colonel Matthias in late October went to Oak Ridge's East Village to inspect the units. Following his return to Hanford, the area engineer coordinated with District officials to procure sample prefab units and to arrange for an on-site inspection visit by a Tennessee Valley Authority portable housing specialist. The decision to use portable dwellings as supplemental housing at Richland came in late December, at which time Manhattan selected the Prefabricated Engineering Company of Portland, Oregon, to supply the units. Du Pont negotiated the initial contract for 500 prefabs, which Matthias approved in early January 1944, and subsequently ordered an additional 1,300, increasing the total of new and existing units to 4,410. Coincident with this activity was Du Pont's expanded construction of other facilities, such as dormitories (eventually 25 to house more than a thousand persons) and commercial and service buildings (stores, schools, churches, recreational areas, and utilities).[17]

To further facilitate community development, the Army approved Du Pont's subcontracting of most construction to two firms familiar with building problems in the Pacific Northwest—Twaits, Morrison, and Knudsen of Los Angeles and Smith, Hoffman, and Wright of Portland. They specified village layouts that took advantage of natural terrain and that preserved existing buildings, orchards, shade trees, roads, and streets. They endorsed house plans that included basic furnishings, recognizing the great difficulty workers from other parts of the country would have in getting their household goods moved in a wartime economy and the limited availability of home furnishings in stores in towns near the site.[18]

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[16] MDH, Bk. 4, Vol. 3, pp. 8.3–8.8, DASA; Ms. Hageman, "Hanford: Threshold of an Era," 1946, p. 34, MDR; Dist Engr Monthly Rpts on DSM Proj, Oct–Nov 43, MDR; Groves, *Now It Can Be Told*, p. 89; Matthias Diary, 18 May, 3 and 24–25 Sep 43, OROO; Du Pont Constr Hist, Vol. 1, pp. 108–10, and Vol. 4, pp. 1223–25, HOO.

[17] MDH, Bk. 4, Vol. 3, pp. 8.5–8.28, passim, and Vol. 5, App. B51 (Chart, Richland Village Constr Progress), DASA; Ms. Hageman, "Hanford: Threshold of an Era," 1946, pp. 34–35, MDR; Ltr, Matthias to TVA, Attn: Gordon Clapp, 11 Dec 43, Admin Files, Gen Corresp, 620 (Hanford), MDR; Dist Engr Monthly Rpts on DSM Proj, Jan and May–Jun 44, MDR; Matthias Diary, 26 and 28–29 Oct, 8, 14, 16, 23–24 Nov 43 and 12 Jan 44, OROO; Du Pont Constr Hist, Vol. 1, pp. 109–10 and 116–46, and Vol. 2, pp. 1226–29, HOO.

These timesaving measures, for the most part, were effective. Construction of the village moved ahead on schedule, and the district engineer reported to General Groves in February 1944 that the village was more than half finished. There were occasions, nevertheless, when serious delays were avoided only as a result of direct and vigorous efforts of the Hanford area engineer. A typical case was Prefabricated Engineering's problem of transporting its portable housing units to the village site.[19]

Prefabricated Engineering lacked the equipment necessary to truck its portable housing units to Richland from its manufacturing plant in Toledo, Oregon. So, in early 1944, it subcontracted the job to a Chicago-based trucking firm and arranged for routine clearances from the Office of Defense Transportation and the Interstate Commerce Commission. Shortly thereafter, unforeseen complications developed. As soon as the trucker began assembling his equipment in Oregon, both government agencies raised strong objections to the fact that Prefabricated Engineering was not conforming to established rules, stating that wartime regulations on conservation of scarce resources required the company to employ local truckers. At the same time, Pacific Northwest representatives of the International Brotherhood of Teamsters threatened to forbid use of union drivers, claiming that the trucking firm's equipment did not meet union safety standards.

Apprised of this threatened delay in the shipment of the portable housing units, Colonel Matthias took immediate action. As a first step, in an effort to relieve Prefabricated Engineering's overtaxed storage facilities and to prevent any serious disruption of the Richland construction schedule, he arranged to have the prefab units transported by rail—a much more costly procedure—until such time as the obstacles to trucking could be overcome. He then assumed the role of a mediator in ongoing union-government negotiations, which dragged on until April 1944. Matthias was successful in overcoming the objections of the Teamsters union, but not those of the government agencies. Consequently, Prefabricated Engineering was left with no alternative but to engage the services of a local trucking firm, even though the latter's per-unit hauling cost was considerably higher than that of the Chicago company.[20]

By late spring of 1945, transformation of the little rural hamlet of Richland into a bustling industrial community of scientists, engineers, military administrators, and skilled workmen and their collective families was very nearly complete. In a fenced-in area at the center of the operating village were the wood-frame buildings of varying size that housed the HEW administrative headquarters. Immediately to the east and southeast of the headquarters and toward the low-lying Columbia River was "downtown" Richland, built around the original commercial center of the village. Here were stores and a variety of service facilities, a hotel for visitors, a theater, churches, a cafeteria, and the dormitories for single men and women. Surrounding downtown on the south, west, and northwest were residential areas, with neighborhood stores and service facilities. Most of the conventional houses were clustered in two large sections—one directly south of the village center, the other to the northwest—with here and there shade and fruit trees remaining from the farms that had occupied the area. On the outer fringes of the conventional housing sections were a few of the flat-roofed prefabricated houses, but most of the homes of this type were concentrated in a roughly rectangular zone directly west of the administration buildings. Several main streets, which interconnected with the many new residential streets, carried motor traffic northward from the village to the production plant area and south and east to Kennewick and Pasco. A newly built railroad spur line gave Richland a direct connection with the Union Pacific and Northern Pacific Railroads a few miles to the south of the village.[21]

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[18] MDH, Bk. 4, Vol. 3, pp. 8.8–8.9 and 8.12–8.13, and Vol. 5, pp. 8.3–8.5 and App. B4, DASA; Du Pont Constr Hist, Vol. 1, pp. 111-12, 288, 292–93, 301–02, 317, and Vol. 4, p. 1228, HOO.

[19] Dist Engr, Monthly Rpts on DSM Proj, Feb 44, MDR; Matthias Diary, Dec 43–Feb 44, passim (especially 28 Dec 43 and 1 and 25–26 Jan 44), OROO; Du Pont Constr Hist, Vol. 4, pp. 1223–25 (Chart, Richland Village Constr Progress), HOO.

[20] Matthias, sub: Chronological Rpt on Hauling Prefab Houses from Toledo, Oreg., to HEW, 16 Jul 45; Ltr, Matthias to Groves, sub: Cost of Hauling Prefab Houses to Richland, 19 Jul 45; Office Memo, Gavin Hadden (Groves's Asst) to Groves, sub: Matthias Rpt (16 Jul 45) and Ltr (19 Jul 45) on Cost of Hauling Prefab Houses to Richland, 26 Jul 45; Memo, Groves to Matthias, sub: Chronological Rpt on Hauling Prefab Houses from Toledo, Oreg., to HEW, 31 Jul 45. All in Admin Files, Gen Corresp, 620 (Hanford), MDR.

Community Management

Du Pont had complete responsibility for community management functions. The Hanford area engineer's role was largely supervisory except on certain matters, such as controls over rents and real estate transactions. Colonel Matthias established a Community Management Branch in the Engineering and Maintenance Division of his office to exercise these controls; review contracts; maintain records on facilities, leases, and financial statements; and work with Du Pont's HEW Service Department. The company assigned overall community management to one of the two assistant superintendents in this department. Division supervisors managed housing, commercial concessionaires, community services, public buildings, and other facilities.[22]

Hanford Camp

For the Army and Du Pont, administration of the Hanford camp presented almost as many problems as building it. To ensure its efficient operation, Du Pont, with Army approval, btained in April 1943 the services of he Olympic Commissary Company of Chicago, a professional management rganization. Olympic assumed responsibility under its contract for operation and maintenance of housing (except trailer plots, which Du Pont rented directly), mess hall, and recreational facilities. Du Pont also arranged leases with private operators for stores, garages, a laundry, a bank, and similar commercial services. It left administration of the schools in the hands of the Washington State Department of Education. Du Pont, however, retained direct responsibility for fire protection and maintained a Hanford Patrol to police the camp.[23]

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[21] MDH, Bk. 4, Vol. 5, Apps. A (Map, Richland Area) and B51 (Chart, Richland Village Constr Progress), DASA; Ms, Hageman, "Hanford: Threshold of an Era," 1946, Map Annex (HEW), MDR; Matthias Diary, 29 Nov 43, OROO; Groves, *Now It Can Be Told*, p. 89; Du Pont Constr Hist, Vol. 1, pp. 105 and 107–46, and Vol. 4, pp. 1233–1318 (photographs of area and structures with descriptions), HOO.

[22] Contract W-7412-eng-1 (Du Pont), 8 Nov 43, OROO; MDH, Bk. 4, Vol. 6, p. 9.1 and Apps. B8 (Org Chart, Hanford Area Engrs Office) and B12–B13 (Org Chart, Du Pont's HEW Svc Dept), DASA; Du Pont Opns Hist, Bk. 17, Pt. 1, pp. 1–14, HOO.

The Army kept close check on the performance of the various organizations providing services for Hanford. On his periodic inspection trips to the camp, General Groves gave close attention to Olympic's management of mess halls and housing. As a result of his complaints concerning certain deficiencies, Du Pont directed a reorganization of the company's operations in June 1943. Again in December, the area engineer reported to Du Pont that management practices still needed some reinforcing in the opinion of the Manhattan commander, who felt "there is no reason why the large losses recently being incurred in camp operations could not be reduced." Finally, in February 1944, after further changes in Olympic's methods of operation, Groves indicated satisfaction with its management of the camp.[24]

Because of the temporary character of the Hanford camp, Manhattan sacrificed comfort and convenience and provided only minimum amenities in the housing facilities. This policy caused considerable dissatisfaction among Hanford residents, some of whom filed complaints with the War Manpower Commission. In response to inquiries from commission officials investigating these complaints, Groves explained that the Army had to avoid overelaboration and overexpenditure because of the wartime shortages of construction materials and labor and the need to adhere to rigid construction schedules. Subsequently, a project survey determined that the unsatisfactory living conditions at the camp were a chief factor in the continual turnover of construction personnel, which approached an unacceptable rate of 21 percent in the crucial summer of 1944.

Other factors contributing to the discontent were the demoralizing sandstorms, the lack of sizable towns to visit outside the reservation, overtaxed commercial facilities, and the segregated housing policy. The latter policy precluded families, even husbands and wives, from living together and restricted occupancy on the basis of sex and race. Recognizing, however, that some needed workers would accept jobs on the project only if they could bring their families, Du Pont and the Army decided reluctantly to permit them in the trailer camps and provided schools for their children, but the policy remained to discourage family groups.[25]

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[23] MDH, Bk. 4, Vol. 5, pp. 5.12–5.18, Apps. B4 and B23, DASA; Matthias Diary, 25 Mar 43, OROO; Du Pont Constr Hist, Vol. 1, pp. 91 and 154–62, HOO.

[24] Matthias Diary, 18 and 23 Jun and 7 Dec 43 (source of quotation) and 18 Feb 44, OROO.

Unfortunately, neither the Army nor Du Pont could do very much about most of these problems in the few months that were still required to complete the production plants. What was feasible, they decided, was to pursue more intensively all available means to raise and maintain the morale of the workers, with the aim of making them more willing to accept the unavoidable hardships. Manhattan officials, including General Groves, spoke to assembled groups and the camp newspaper, "The Sage Sentinel," carried stories emphasizing the importance of the project to the war effort. Du Pont, with considerable assistance from the area engineer, greatly expanded the recreational facilities. They brought nationally known entertainers and popular orchestras to the auditorium-gymnasium, which also doubled as a gigantic dance hall; they encouraged regular use of recreation halls for men and women; they arranged for nightly motion pictures in a quickly erected tent theater; and they provided taverns, bowling alleys, a four-thousand-seat baseball stadium, nine softball diamonds, and many tennis, badminton, volleyball, and horseshoe courts. Groves himself directed that beer be sold in whatever quantities needed and the Hanford Works Employees Association licensed a concessionaire to install 150 pinball machines. The program was effective and wartime residents of Hanford would later recall that the camp came to have "a kind of gaiety, a temporary feeling, the mood of a fair or carnival or circus,"[26] all enhanced by the continuous playing of music over a public address system. Job terminations declined and in the hectic months of late 1944 and early 1945 the construction work force brought to completion, on schedule, the great production units of the plutonium plant.[27]

Richland Village

For Du Pont and the area engineer, management of the Richland village entailed all the usual problems of a rapidly expanding wartime community, as well as the special problems arising from the unique character of the atomic project. From 1943 through early 1945, provision of adequate housing for the work force was certainly one of the most challenging problems for the village managers. Lacking reliable guidelines to allocate housing to the three major groups of employees that made up the work force—construction, operations, and government personnel—managers frequently had to shift percentages, depending upon current need. Before January 1944, they allocated most housing to construction and government personnel, gradually altering the basis until by March 50 percent was going to operating employees, 40 percent to construction, and 10 percent to government. After the peak of construction passed, the population of Richland declined to the extent that some prefabricated houses were vacated. Occupants of houses in Richland paid rentals of between $27.50 and $80.00 a month, the amount varying in relation to the size and type of unit, and whether or not it was furnished. The rent included all utilities. Dormitory occupants paid from $15.00 to $22.50 per month.[28]

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[25] Matthias Diary, 6 and 18 May, 3–4 and 18 Jun, 21 Aug, 26 Oct, 14 Nov 43, OROO; Ltrs, Lawrence A. Appley (Dep Chairman and Ex Dir, WMC) to Groves, 23 Dec 43, and Groves to Appley, 7 Jan 44, Admin Files, Gen Corresp, 620 (Hanford), MDR; Du Pont Constr Hist, Vol. 1, pp. 86–91, and Vol. 4, pp. 1361–65, HOO.

[26] Van Arsdol, *Hanford: The Big Secret*, p. 29. See also pp. 50–53.

[27] MDH, Bk. 4, Vol. 5, pp. 5.13–5.14, DASA; Matthias Diary, 6 May 43 and 18 Feb 44, OROO; Groves Diary, 10 and 18 Feb 44, LRG; Groves, *Now It Can Be Told*, pp. 89–93; Du Pont Constr Hist, Vol. 1, pp. 163–72, Vol. 2, pp. 409–11 and 415–17, and Vol. 4, pp. 1342–44, HOO.

As in the Hanford construction camp, concessionaires operated most of the commercial facilities in the village under contracts negotiated by Du Pont's HEW Service Department. The department employed competitive bidding in selecting the concessionaries, choosing those offering maximum service to the village and the highest monetary return to the government. These commercial operators made available to residents of the community all normal items and services essential to daily living, such as food, drugs, clothing, and entertainment, and department officials periodically checked prices in order to maintain them at levels comparable to those at stores in nearby towns. In most cases the government provided building space, including stationary fixtures, for the concessionaire and the latter furnished any mobile equipment required.[29]

During World War II the Richland community had no formally constituted institutions of local government. Du Pont, through its HEW Service Department, provided Richlanders with most normal community services—utilities, street maintenance, trash and garbage pickup, and fire and police protection. A division of the company's Plant Patrol, deputized by the sheriff of Benton County, served as the village police force, enforcing traffic regulations, investigating accidents, and overseeing a program of crime prevention. One exception to this pattern of Du Pont control was the public schools: The federal government furnished and maintained the buildings, and the instructional staff functioned under the jurisdiction of the local county superintendent of schools. Du Pont and Hanford Area Engineers Office representatives served as advisory members of the Richland school board, comprised of local residents. Most of the money for operating the schools came from the federal government under provisions of the Lanham Act. Another exception was public transportation, including a government-owned bus system that the area engineer administered.[30]

Of the District's three operating communities, Richland village most nearly resembled the typical American company town, owned and dominated by a great industrial concern. This was so partly because the Army's presence was not nearly so apparent as at Oak Ridge, with its District headquarters and numerous technical employees in uniform, nor as at Los Alamos, with its very substantial military population. Richland also had fewer outward ramifications of physical security, such as the high encircling fence patrolled frequently by military police and dogs at the New Mexico site and the similar barriers erected at crucial points along the boundary of the Tennessee site. To the uninformed casual visitor, the plutonium community appeared to be just one more wartime boomtown where the average employee and his family had to endure the usual minor hardships and inconveniences.

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[28] MDH, Bk. 4, Vol. 6, pp. 9.1-9.7 and App. B5, DASA; Du Pont Opns Hist, Bk. 17, Pt. 2, pp. 1-31, HOO.

[29] MDH, Bk. 4, Vol. 6, pp. 9.14-9.16 and App. B4, DASA; Du Pont Opns Hist, Bk. 18, Pt. 2, pp. 1-2 and 5.6, HOO.

[30] MDH, Bk. 4, Vol. 6, pp. 9.7-9.14 and Apps B4-B5 and B12-B13, DASA; Du Pont Opns Hist, Bk. 17, Pt. 1, pp. 4-5, HOO.

CHAPTER XXIII

The Atomic Communities in New Mexico

Manhattan Project leaders' choice of isolated and remote sections of central New Mexico for developing and testing the atomic bomb transformed two hitherto sparsely populated regions into two unique scientific communities. Some 20 miles west of the famous Santa Fe Trail, the rugged Pajarito Plateau became the site of the Los Alamos reservation, the operating community comprising the bomb development laboratory with technical installations and a residential area; and some 160 miles south of Los Alamos, the desolate Jornada del Muerto valley provided the location for the Trinity base camp, the temporary community comprising a bomb test area with technical facilities and a campsite. Because of the geographic inaccessibility and arid climate of these regions, few of the thousands of persons who came into the Southwest—either over the trail or the railroad that replaced it—chose to settle there, further enhancing their suitability for the highly secret activities of the bomb development project.[1]

Los Alamos: The Operating Community

With the often snow-capped peaks of the Sangre de Cristo Mountains looming in the distance, the broad expanse of the Pajarito Plateau extended westward from an altitude of 7,300 feet at Los Alamos to the heavily wooded slopes of the 9,000-foot Jemez Mountains and eastward to the wide Rio Grande valley. Bypassed by the mainstream of settlement and development, there were only a few scattered ranches on the great plateau by the early years of the twentieth century. Of these ranches, the one situated atop the Los Alamos mesa—locally referred to as the Hill—attracted the interest of two different purchasers, each with a different objective. In 1917, to realize a long-standing dream, former Detroit businessman Ashley Pond had bought the ranch as the location for his Los Alamos Ranch School for Boys. A quarter of a century later, to meet Manhattan Project goals, the Army acquired this same ranch as the location for one of its atomic reservations.[2] (*See Map 5.*)

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[1] Lansing Lamont in his history of the atomic bomb (*Day of Trinity* [New York: Atheneum, 1965], p. 70) suggests that Oppenheimer, pressed by Bainbridge for a suitable code name for the desert site, selected "Trinity," having just read the opening lines of John Donne's Holy Sonnet XIV: "Batter my heart, three-person'd God; for you / As yet but knock, breathe, shine, and seek to mend." On the Santa Fe Trail see *Dictionary of American History*, rev. ed., s.v. "Santa Fe" by Francis Borgia Steck and "Santa Fe Trail" by Bliss Isely.

Planning

On a wintry day in early November 1942, a small group of Army engineer officers visited the Los Alamos Ranch School. Of the several possible sites they had examined, this one impressed them most as nearly meeting all their criteria for security, safety, ease of acquisition, and conversion into a scientific research and development community. There was a large enough area cleared of timber to permit an immediate start on the erection of technical structures and the buildings of the school would provide more than sufficient housing for the relatively small group of scientists who would staff the bomb laboratory. Following Groves and Oppenheimer's inspection and approval a few days later, the War Department notified the owners of the school that the government was starting condemnation proceedings to acquire the property and that they had until mid-February 1943 to vacate, time enough for members of the small student body to complete their academic studies for the year.[3]

Weeks before the students finally departed from the Hill, plans to secure a construction contractor and, as Stone and Webster's replacement, a new architect-engineer for the Los Alamos community development program were already under way. The Albuquerque District surveyed construction firms in the region and, as the construction contractor, chose the M. M. Sundt Company of Tucson, Arizona, which was just completing a job for the Army at a camp near Las Vegas, New Mexico. The firm appeared attractive for the task not only because it had available nearby equipment and manpower but also because, unlike many construction companies, it had its own fleet of trucks and operated its own plumbing, electrical, and painting departments. This meant that Sundt would have to employ fewer subcontractors, a plus from the standpoint of project security.

When the Army signed its lump-sum contract with Sundt in mid-December, company representatives were already in Santa Fe securing office quarters and initiating procurement for workmen and building materials. These expeditious efforts permitted Sundt crews to begin clearing the site by the end of the month, when the Army also completed negotiations with Willard C. Kruger and Associates of Santa Fe to be the new architect-engineer. Kruger's location near the newly established Santa Fe Engineers Office and the area office of the construction contractor facilitated the firm's ability to cope promptly with changes and expansions in the community.[4]

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[2] "The First 20 Years at Los Alamos, January 1943–January 1963," *LASL News* 5, no. 1 (Jan 63): 8–13.

[3] See Ch. XV for details on acquisition of the Los Alamos site. See also "First 20 Years at Los Alamos," pp. 12–13, and James W. Kunetka, *City of Fire: Los Alamos and the Atomic Age, 1943–1945*, rev. ed. (Albuquerque: University of New Mexico Press, 1979), pp. 10–16.

[4] MDH, Bk. 8, Vol. 1, "General," p. 4.1–4.2, 5.1–5.2, App. D12 (Major Contracts Supervised by Albuquerque Dist to Mar 44), and Vol. 2, "Technical,"

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TYPICAL BUILDING AT THE LOS ALAMOS RANCH SCHOOL FOR BOYS

Kruger used Stone and Webster's original plans for Los Alamos, which incorporated the ideas and specifications of Oppenheimer and other project scientists, as the basis of its initial blueprints for the community. In these early plans, drawn up in late 1942 and approved by the prime contractor, the University of California, the fifty-four school buildings formed the nucleus of the community, with the new houses, dormitories, barracks, service, and other buildings of the nontechnical area located to the northeast and with the installations of the technical area, enclosed by a high chain link fence, located to the south along the precipitous rim of Jemez Canyon. But these early plans constituted only a rudimentary beginning for construction on the Hill. Further planning in early 1943 by Groves and scientific leaders of the project, especially Oppenheimer and James B. Conant, revealed that the bomb development program was going to be a far larger enterprise than originally anticipated and that precise answers to questions concerning the size of the laboratory, its staff, technical facilities, and supporting community would become available only after a great deal more study and research.[5]

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pp. I.5–I.6, DASA; "First 20 Years at Los Alamos," p. 36; Fine and Remington, *Corps of Engineers: Construction*, p. 694.

[5] MDH, Bk. 8, Vol. 1, Apps. A6 (Post Plan) and A7 (Tech Area Plot Map), and Vol. 2, p. III.47, DASA; Second Memo on Los Alamos Proj (by J. H.

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As at Clinton and Hanford, there was the same urgency at Los Alamos to complete facilities in the shortest possible time and at the lowest cost in terms of manpower and critical materials. Hence, wherever feasible, design and layout procedures were streamlined. On nontechnical community structures (housing, service, and recreational buildings), the Albuquerque District submitted requirements directly to Kruger without going through the University of California. Kruger then outlined the job specifications to each subcontractor, who in turn provided a cost estimate. Once Kruger and the subcontractor had agreed on a reasonable cost, the proposal was submitted in the form of a lump-sum contract to the Albuquerque District. The latter office reviewed the document and calculated the profit made, and if this appeared excessive, it required the subcontractor to return the overage.[6]

Plans for the New Mexico establishment followed the general pattern of those for Clinton and Hanford: highly tentative and subject to repeated and drastic vicissitudes. Nevertheless, on one project requirement—that of security—Manhattan remained vigilantly uncompromising. Because the need for secrecy was so crucial, Los Alamos, unlike Clinton and Hanford, was planned as a military post, with a military commander and staff and various military units to perform post engineer and security functions. For the same reason, project planners decided to provide on-site accommodations and community services (commissary, medical care, and recreation) for all military personnel and civilian scientists and technicians, and, in many cases, their families as well, because of their respective post functions and secret job assignments. As nontechnical civilian employees working in unclassified jobs did not pose a security risk, Manhattan recommended that they reside in the neighboring small towns and use Army bus transportation to commute to and from the job. They would, however, have access to on-site housing based on its availability and their family need.[7]

Construction and Operation

Because of the unpredictable expansion in the size of the bomb development program, community construction tended to be an open-ended process, with each new influx of civilian and military personnel requiring additional facilities. Housing constituted by far the largest part of community construction, reflecting a rapidly expanding population. From an estimated fifteen hundred persons in January 1943, comprised mostly of Sundt construction employees, the population increased to almost thirty-five hundred a year later, although most Sundt personnel had departed, and approached fifty-seven hundred at the beginning of 1945.[8]

Stevenson, Proj Mgr), Admin Files, Gen Corresp, 322 (Los Alamos), MDR; "First 20 Years at Los Alamos," pp. 15–19 (photographs of terrain features and buildings); Rpt, sub: Complications of the Los Alamos Proj, 12 Nov 46, Admin Files, Gen Corresp, 322 (Los Alamos), MDR. Daniel Lang provides a detailed description of Los Alamos as he observed it in the immediate postwar period (1945–48) in his *Early Tales of the Atomic Age* (New York: Doubleday and Co., 1948), pp. 208–10.

[6] MDH, Bk. 8, Vol. 1, pp. 4.2–4.3 and 5.1, DASA.

[7] Ibid., pp. 5.1–6.3, DASA.

[8] All statistics on the population of Los Alamos in wartime represent rough estimates, because project

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With the completion of the first major phase of community construction in the fall of 1943, the Sundt Company withdrew its personnel and equipment from the site and the post commander prepared to take over primary responsibility for community maintenance as well as any further minor construction. General Groves had been concerned about having an outside contractor and the Albuquerque District involved in the bomb program and he now took steps to tighten security. In early 1944, the Manhattan District assumed full responsibility for supervising all further construction. Lt. Col. Whitney Ashbridge, the post commander, recruited additional carpenters, plumbers, and other workers and assigned them to the Operations Division, which he reorganized into two sections: one for community maintenance and construction, the other for technical area work. Work crews from the division, often comprised of both civilians and enlisted men from the Provisional Engineer Detachment (PED), undertook many minor construction jobs ordinarily carried out by construction contractors.

Division crews, however, could not handle all the work, and occasionally outside contractors were brought in through the Albuquerque District. An increase in the number of outside contractors employed by Manhattan occurred in March 1944, when both the technical and community facilities had to be expanded substantially. The Army once again had to risk calling upon the Albuquerque District to begin a search for additional contractors. This time two El Paso, Texas, firms were chosen: J. E. Morgan and Sons, to install prefabricated apartment buildings; and Robert E. McKee, to undertake the new phase of technical construction.[9]

The unpredictable expansion of the bomb program consistently outran available housing. With on-site housing still under construction in the spring of 1943, the first laboratory staff members had to stay at guest ranches in the vicinity of the Hill. By June, these accommodations were so overtaxed by the influx of technical personnel that the Army had to acquire the National Park Service's Frijoles Lodge in Bandelier National Monument, 14 miles south of Los Alamos. From June to October 1943 and again for a brief period in July–August 1944, overflow laboratory personnel resided at the Frijoles Canyon lodgings amid the ruins of ancient Indian dwellings. In 1944 and 1945, the unavailability of sufficient dormitory housing for married enlisted men of the Special Engineer Detachment (SED) and the strict enforcement of security regulations that forbade bringing wives to live in nearby civilian communities severely strained the morale of many junior scientists and technicians. The continuing shortage of family-type facilities resulted not only from the unexpectedly rapid increase in personnel and the wartime

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officials, for reasons of security, did not undertake an official census until April 1946. However, some indication of population trends can be derived from payroll figures maintained for the various categories of workers employed at Los Alamos. See ibid., p. 7.15 and App. B7 (Payroll Census Graph, Dec 42–Dec 46), DASA.

[9] Ibid., pp. 5.4–5.9 and Apps. B3–B4 (Org Charts, 4 Feb 44 and 1 Feb 45) and D12, DASA; Fine and Remington, *Corps of Engineers: Construction*, pp. 697–98.

FOUR-FAMILY APARTMENT UNITS AT LOS ALAMOS

limitations on labor and materials but also from the deliberate policy of holding to a minimum the construction of family housing, except where it contributed to recruiting personnel and security. The Army persisted in this policy because the addition of each new family placed further strain upon the limited number of service personnel available, the supply of water, electricity, and fuel, the sewerage system, and other community services.[10]

Housing units at Los Alamos comprised numerous conventional houses, apartments, and duplexes, which the Army felt were of particular value for recruiting essential personnel and for ensuring security. There were also winterized hutments, Pacific and National Hut apartments, government- and privately owned trailers, and sixteen remodeled ranch houses at various places on the reservation. Eventually the combined capacity of these various types of housing was sufficient to accommodate more than six hundred families.

Single individuals resided in barracks or dormitories, with the best-equipped dormitories reserved for unmarried scientific personnel. Firemen, janitors, hospital attendants, and other civilian service personnel

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[10] MDH, Bk. 8, Vol. 1, pp. 6.2–6.3, and Vol. 2, pp. I.9, III.19, IX.11, DASA; "First 20 Years at Los Alamos," pp. 16–17; Dorothy McKibbin, "109 East Palace Avenue," *LASL News* 5, no. 14 (Jun 63): 6. Mrs. McKibbin was in charge of Los Alamos' Santa Fe office, located at the above-mentioned address, which served as the first point of contact for most incoming visitors and newly assigned personnel.

MILITARY MESS FACILITY AT LOS ALAMOS

occupied more cheaply built units. Most enlisted men had quarters in theater of operations-type barracks and enlisted women in modified mobilization-style units. Construction workers occupied temporary housing built by their employers; Sundt crews resided in more than 100 hutments, subsequently used to house other construction workers after the Tucson contractor had completed its phase of the work, and McKee crews lived in a specially built 93-unit dormitory. Visitors to the site and some senior scientific personnel were given quarters in the well-built stone-and-log structures of the Ranch School.[11]

As an antidote to the admittedly unsatisfactory housing conditions, the isolation of the site, and the stringent security regulations, the Army devoted considerable effort to providing Los Alamos residents with efficient, low-cost, and attractive food and service facilities. Meals were available to civilians at cost in several conveniently located messes and at Fuller Lodge—the latter intended primarily for guests and transients. Army personnel ate at regular military messes. Limited food service was available in the post exchanges. In March 1945, the post opened a new cafeteria specifically designed and operated to improve community morale. Open to

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[11] MDH, Bk. 8, Vol. 1, pp. 6.2–6.5, DASA; LASL, Personnel Dept, Housing Manual for Laboratory Employees and Supervisors, pp. 21–24; Barbara Storms, "Western Area," *The Atom* 31 (Mar 66): 19–23 and 36; Lang, *Tales of the Atomic Age*, p. 207.

LOS ALAMOS RANCH TRADING POST

Los Alamos Ranch Trading Post

everyone, it was better equipped, furnished, and decorated than the regular messes and served a more elaborate menu offered on an *a la carte* basis at approximate cost.

Commissary facilities began operations in March 1943, with only Los Alamos residents having privileges. But experience demonstrated that the majority of employees who lived off the site had little opportunity to do their shopping in nearby communities because of commuting distances. Consequently, the post commander ordered extension of commissary privileges to all who worked at the reservation. One unusual commissary service was check cashing for contractor employees, who, for security reasons, were not permitted to maintain bank accounts in Santa Fe or other communities adjacent to the site. Another ameliorative measure, as of August 1944, was the sale of many additional items not ordinarily authorized under Army regulations.[12]

Supplementing commissary service were the post exchange facilities, which were open to everyone on the reservation. The Army set up the first "trading post" in a small log building of the Ranch School in early 1943, but eventually opened outlets in several other locations, including one

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[12] MDH, Bk. 8, Vol 1, pp. 6.9–6.14, DASA; Memo, Ashbridge to 1st Lt William Rice (Commissary Off, Los Alamos), 12 Aug 44, and Memo for File, Ashbridge, 12 Aug 44, copies in ibid., App. D24, DASA; Ltr, Col Gerald R. Tyler (CO, Los Alamos) to Dist Engr, Attn.: Col Elmer E. Kirkpatrick, Jr. (Dep Dist Engr), sub: Request for Authority to Cash Checks at Commissary, and 1st Ind, Kirkpatrick to CO, U.S. Engrs Office, Santa Fe, N.Mex., both 12 Feb 45, copies in ibid., App. D27, DASA; LASL, Housing Manual for Laboratory Employees and Supervisors, p. 23.

STREET SCENE IN LOS ALAMOS. *The fence separates the technical installations from the residential area.*

near the entrance of the technical area and, as of June 1944, one convenient to the quarters of the SED unit. The Army, however, discouraged the practice extensively employed at Oak Ridge, Hanford, and Richland of granting commercial concessions to outside civilian businessmen. There were a few exceptions. The post exchange manager let contracts for a cleaning and pressing shop and a combination garage and filling station. Whenever feasible, the Army employed civilians to operate the various service establishments. But, because of the labor scarcity, it had to supplement civilian staffs with Women's Army Corps (WAC) members and PED enlisted men.[13]

Other community services were comparable to those found at most zone-of-interior military posts. Military and civilian crews under the direction of the post engineer officer maintained and repaired all buildings and were capable of undertaking new construction on a limited scale. Other post crews tended furnaces in winter, delivered ice in summer, and collected the community's garbage and trash. The post motor pool operated the community's transportation system, which was completely dependent upon motor vehicles. It provided a free bus service for the hundreds of commuting employees from nearby towns and a trucking service

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(Org Chart, U.S. Engrs Office, Santa Fe, N.Mex., 5 Feb 44), DASA.

[13] MDH, Bk. 8, Vol. 1, pp. 6.16–6.20 and App. B3

PUPILS AT THE LOS ALAMOS COMMUNITY SCHOOL *viewing the Jemez Mountains*

to the nearest railheads in Santa Fe and Albuquerque.[14]

Management

The local government of the Los Alamos community, which, legally speaking, was a federal reservation within the state of New Mexico, functioned through a composite of civilian and military institutions. Although civilian Sundt Company guards performed internal security functions in the earliest months of post operation, the Army provided the community with most of its protective and law enforcement services. A Military Police (MP) Detachment, assigned in late April 1943 from the 4817th Service Command Unit, 8th Service Command, operated under the post provost marshal's direction and was responsible for guarding all points of entry and patrolling the perimeters of both the technical area and the reservation itself. Fire protection also began as a civilian function, first provided by Sundt Company employees and later by its construction crews quartered on the post. Then in October, the Army decided to save scarce housing by replacing civilian firemen with enlisted PED soldiers, who could live in the fire station. They retained only a civilian chief.[15]

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[14] Ibid., pp. 6.22–6.29, DASA; "First 20 Years at Los Alamos," pp. 18–20; List, sub: MD Offs on Duty at Los Alamos and Their Duties, 6 May 44, Incl to Memo, Ashbridge to Groves, 14 Jun 44, Admin Files, Gen Corresp, 201 (Gen), MDR.

[15] See Ch. XV for a further discussion of the legal status of Los Alamos. See also copies of the correspondence between the Secretary of War and the governor of New Mexico in MDH, Bk. 8, Vol. 1, Apps. D9, DASA. Because Los Alamos was a federal reservation, officials of New Mexico held that people residing there were not legal residents of the

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Civil law administration was the responsibility of a town council, comprised of six members whom the residents elected to serve a six-month term of office. Operating at first under a joint directive issued by Ashbridge and Oppenheimer in August 1943, the council ultimately functioned under a constitution approved by the post commander in April 1944. With this authority the council had jurisdiction over enforcement of local civil regulations, but it had to depend upon the residents' voluntary compliance because there was no legally constituted civil court on post to which cases might be remanded. The council, which met regularly with representatives of the laboratory and the post commander, also submitted recommendations on community affairs and devoted considerable time to problems of community welfare. It gave particular attention to measures that would improve living conditions, including establishment and operation of self-help laundries, more convenient hours of operation at post exchanges and messes, provision of extra storage and living space in apartments, reduction in rental rates, and development of children's recreational facilities. Viewing the work of the council in retrospect, General Groves recalls that, though "it was a thorn in the side of the station commander . . . , on the whole it was a valuable adjunct, for it not only improved the morale of the community, but kept the post administration on its toes." [16]

As operating contractor, the University of California had the responsibility for the often difficult and delicate task of administering civilian housing—establishing rental rates and other charges, determining housing assignment quotas, and providing for additional facilities. The university set up an on-site housing office, where an Army liaison officer maintained day-to-day familiarity with developments in this crucial area of community administration. Following the guidance of General Accounting Office regulations, the university determined rates in accordance with the annual salary of the renter and then the district engineer, in compliance with Orders B issued by the War Department in 1943, reviewed and approved these rates. The university established charges for utilities on the basis of a study of rates assessed tenants in other projects where the government furnished housing and then submitted its rate schedule to the District for approval. Although an investigation in the spring of 1944 revealed that these charges were far less than actual costs, the Army decided not to increase them and further aggravate an already restive civilian community.[17]

No effort received more careful attention and wider support from the highly educated scientists and technicians than establishment of a free public school system. In the spring of

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state. Hence, in the presidential election of 1944, they could vote only by absentee ballot. Nevertheless, New Mexico did require that Los Alamos residents pay the state income tax. See ibid., pp. 6.33–6.43 and 6.55, DASA.

[16] Quotation from Groves, *Now It Can Be Told*, p. 164. See also MDH, Bk. 8, Vol. 1, pp. 6.59–6.60, DASA.

[17] MDH, Bk. 8, Vol. 1, pp. 6.5–6.9 and Apps. C.1 (Utility Charges at Los Alamos), DASA; Ltr, Ash-

Continued

1943, because existing school facilities were inadequate to accommodate a burgeoning school-age population, the post commander and laboratory director acted jointly to appoint a six-man school committee (later, a permanent eight-man school board) to supervise the construction of a new school building, plan a curriculum, and employ a teaching staff. As a consultant, the committee hired Walter W. Cook, professor of education at the University of Minnesota. Assisted by B. E. Brazier, the laboratory's construction and maintenance division chief, Cook developed plans for a combined elementary and high school building incorporating all the newest features in school construction. The school opened in the fall with 140 pupils, and enrollment by 1945 rose to more than 300. Later, a partially self-supporting nursery school, primarily intended for the preschool age children of working mothers, supplemented the regular school system. Except for the nursery school, attendance for Los Alamos residents was completely free of charge, with the government paying all expenses (directly for maintenance and, through the University of California contract, for teachers' salaries).[18]

For military personnel at Los Alamos, the Army provided the standard information and education program authorized for military posts. The post chaplain, Capt. Mathew Imrie, who also served as the information and education officer, advised MP, WAC, PED, SED, and other unit commanders on educational matters, arranged regular night school courses, and administered the U.S. Armed Forces Institute correspondence course program.[19]

Strong support for the best educational facilities was at least partially motivated by continuing concern over community morale. Not only did it eliminate one dissatisfaction, but after-hours educational opportunities were a well-tested means for engaging servicemen in a personally satisfying activity during nonduty hours. The causes for declining morale at Los Alamos in 1944 and early 1945 were many. Such irritants as censorship of mail, alleged and real inequities in wages, differences in social background, restrictions on access to service and recreational facilities, and shortages of housing tended to be magnified. Some of these factors, too, enhanced the conflicts that often arise between civilians and the military, especially where, as at Los Alamos, most civilian scientists and technicians came from an academic and social background quite different from that of many of the servicemen.[20]

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bridge to Dist Engr, sub: Rent Reduction for Improvised Quarters, 7 Jan 44, copy in ibid., App. D18, DASA; Ltr, Lt Col J. M. Harman (CO, Los Alamos) to Dist Engr, sub: Establishment of Rates for Quarters for the Operating Contractors' Employees on the Zia (Los Alamos) Proj, 10 Feb 43, copy in ibid., App. D20, DASA; Ltr, Tyler (CO, Los Alamos) to Oppenheimer, Attn.: Charles D. Shane, sub: Rental Rates for Family Quarters, 10 Mar 45, copy in ibid., App. D22, DASA; WD Orders B, 15 Jan 43; Second Memo on the Los Alamos Proj (by Stevenson, Proj Mgr), MDR.

[18] MDH, Bk. 8, Vol. 1, pp. 6.65–6.67 and Apps. C2 (Chart, Total Cost to Govt of Maintaining Schools for Los Alamos During School Years, 1945–46 and 1946–47) and D13 (Data on Misc Post Bldgs), and Vol. 2, pp. III.9–III.10, DASA; Memo, Oppenheimer to Groves, sub: Rpt of Spec Reviewing Committee on Los Alamos Proj, 27 May 43, Admin Files, Gen Corresp, 600.12 (Development), MDR; Groves, *Now It Can Be Told*, p. 166.

[19] MDH, Bk. 8, Vol. 1, pp. 6.56–6.57, DASA.

[20] Ibid., Vol. 2, pp. III.11, III.13–III.14, III.19–

Continued

Typical of morale problems was a custodial employee's complaint of racial discrimination (in this case, against a person of Spanish ancestry) in assignment of housing. The employee wrote to both of New Mexico's United States senators that post housing authorities had forced him to move out of an apartment that he had occupied for some time into inferior quarters, in order to make room for newly arrived scientific and technical personnel. The Army informed the two senators that the District had built the housing in question for occupancy by highly paid staff members of the laboratory. Pending arrival of this professional personnel in Los Alamos, housing officials had permitted custodial employees to live in it on a temporary basis. Now these employees were being reassigned, without regard to race or nationality, to other quarters that were in every respect adequate for their needs. To make certain that the rather large number of other Spanish-Americans living on the post fully understood the reasons for reassignment of housing units, Colonel Ashbridge met with representatives of the group, assuring them that the Army was continuing its efforts to relieve the housing shortage.[21]

To check the erosion of morale, the Army, through its Special Services organization on the post, pursued a vigorous program of countermeasures in other areas of community activity. Special Services greatly expanded a limited civilian program, begun by a former teacher of the Ranch School. It added tennis courts, softball fields, a golf course, and a bowling alley; assisted residents in taking advantage of the unexcelled opportunities for outdoor recreation (camping, hiking, skiing, and mountain climbing); provided motion pictures and other programs in the two post theaters; and encouraged residents to sponsor such activities as lectures, dances, art shows, and monthly musicals. The Army also encouraged residents to organize and participate in those typical groups found in most American communities—Boy Scouts, a chess club, a little theater group, and so on—and assigned the post chaplain responsibility for arranging religious services after the part-time services by priests and ministers from Santa Fe had proved generally unsatisfactory.[22]

Given the inherent character of many of the factors that adversely affected morale, the Army, of course, could never hope to find completely satisfactory solutions for all the problems of the Los Alamos community. Nevertheless, it was largely successful in preventing any of these factors from seriously disrupting the life of the operating community and thereby impeding or delaying development of the atomic bomb.

III.22 DASA; Rpt, sub: Complications of Los Alamos Proj, 12 Nov 46, MDR; Groves, *Now It Can Be Told*, pp. 164–66 and 168–69.

[21] See correspondence in Admin Files, Gen Corresp 330.14 (Los Alamos), MDR especially Ltr, Sen Carl A. Hatch (N.Mex.) to Secy War, 6 Mar 44, and attached suggested reply prepared in Groves's office, Ltr, Col R. R. Nevland (Div Engr, Dallas, Tex.) to Sen Dennis Chavez (N.Mex.), 18 Mar 44; and Memo, Ashbridge to Groves, 20 Mar 44.

[22] MDH, Bk. 8, Vol. 1, pp. 6.55–6.56, 6.57–6.58, App. D12, DASA; Groves Diary, 24 Jul 44, LRG.

Trinity: The Base Camp

The establishment of the Trinity base camp in the Jornada del Muerto valley east of the Rio Grande in New Mexico brought suddenly, albeit for a very brief time, a great influx of men and machines to a region hitherto home for only a few hardy farmers and ranchers.[23] Unlike the residents of the temporary Hanford construction camp in the sagebrush wilderness west of the Columbia River in Washington State, the men of Trinity were highly trained scientists and technicians from the parent community of Los Alamos who had trekked from the Pajarito Plateau to the desolate Jornada to complete their unique military-scientific mission: the test of an atomic device. Dedicated in their commitment to science, they now turned to preparing the Trinity site for this dramatic event, which, in an instant, would alter, decisively, the course of human history.

Flanked by low-lying mountains that added a certain primitive beauty to the otherwise drab sameness of the seemingly endless desert landscape, the Trinity site comprised an 18- by 24-mile tract of land in the northwest corner of the Jornada, which itself formed the northern portion of the huge Alamogordo Army Air Field (*Map 6*). In the summer of 1944, Kenneth Bainbridge, the Harvard physicist assigned by Oppenheimer to oversee preparations for the bomb test and the base camp, chose this expanse of New Mexico desert over several other locations because he felt it best met the criteria established by Los Alamos scientists: flat terrain for minimizing extraneous blast effects and for construction of roads and communications lines; sufficient distance from populated areas but close enough to Los Alamos to avoid an undue loss of time in travel by laboratory staff members; clear and sunny weather, on the average, that would permit the extensive collection of optical data; and convenience to good transportation by rail (main line of the Atchison, Topeka and Santa Fe Railroad) and by highway (U.S. 85 and 380).[24]

Beginning in the fall, Bainbridge and his Project Trinity group worked closely with Capt. Samuel P. Davalos, post engineer at Los Alamos in charge of the Operations Division's Technical Area Section, to develop plans for a base camp at the Trinity site, to include a bomb test area with technical facilities and a campsite that would serve the needs of at least 160 men. Meanwhile, to expedite construction at the camp, the Army arranged a contract with a Lubbock, Texas, construction firm, which soon dispatched workmen to Trinity to build barracks, officers quarters, a mess hall, and other support facilities. At the end of December, when these basic facilities were completed, a

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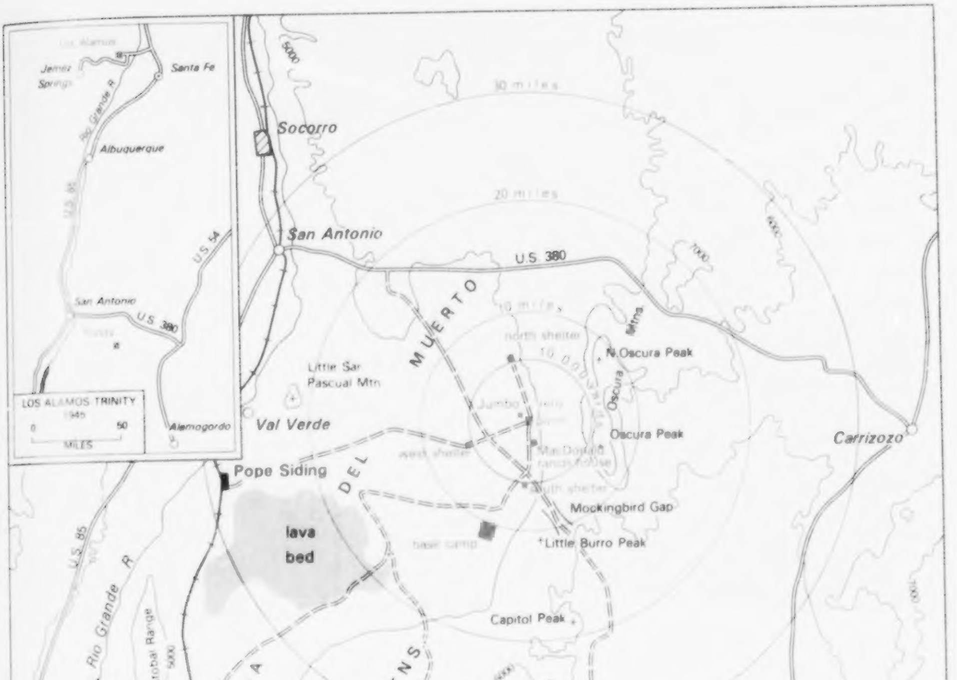
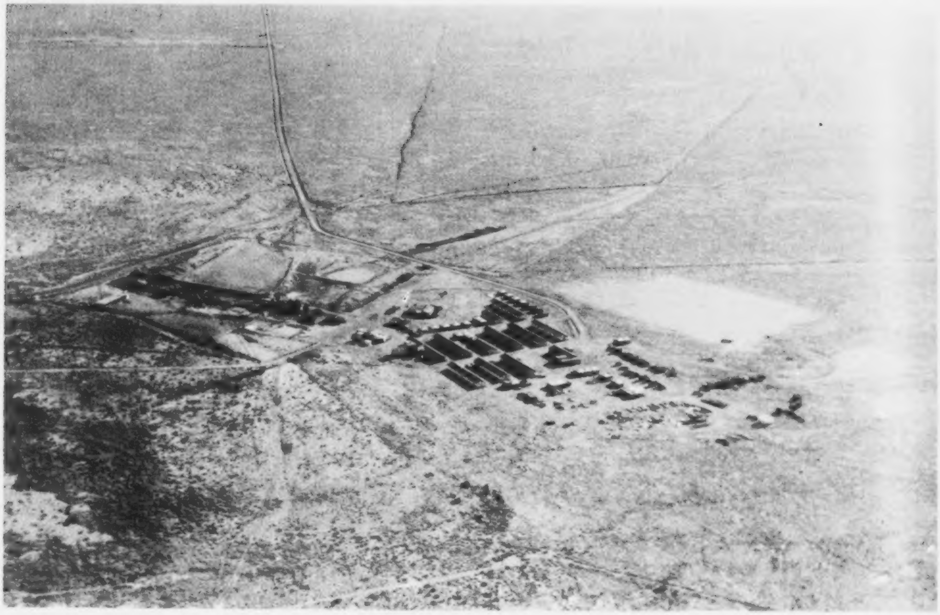
[23] Section on the Trinity site based on MDH, Bk. 8, Vol. 1, pp. 6.30 and 7.10-7.11, and Vol. 2, pp. XVIII.2-XVIII.4, DASA; Lamont, *Day of Trinity*, pp. 73-76 and 94-95; Kunetka, *City of Fire*, pp. 145-49.

[24] The choice of the Trinity site came after Bainbridge's group had considered seven other possible locations for the test: three in New Mexico (the Tularosa valley northwest of the town of Alamogordo, the lava region south of Grants, and the plateau southwest of Cuba and northeast of Thoreau); two in California (the Army's desert training area in the southeast part of the state, near Rice, and San Nicolas Island in the Pacific Ocean, southwest of Los Angeles); one in Texas (the sandbars off the south coast); and one in Colorado (the San Luis Valley region near the Great Sand Dunes National Monument). See MDH, Bk. 8, Vol. 2, p. XVIII.2, DASA.

Los Alamos
Jemez Springs
Santa Fe
Rio Grande R
Albuquerque
U.S. 85
U.S. 54
San Antonio
U.S. 380
Trinity
Alamogordo
LOS ALAMOS-TRINITY
1945
0
50
MILES
Socorro
30 miles
20 miles
10 miles
San Antonio
U.S. 380
MUERTO
DEL
JORNADA
north shelter
10,000 yards
N.Oscura Peak
Oscura Mtns
Little San Pascual Mtn
Jumbo
zero
point
Val Verde
Oscura Peak
west shelter
MacDonald ranch house
Carrizozo
Pope Siding
south shelter
Mockingbird Gap
lava bed
base camp
Little Burro Peak
U.S. 85
Rio Grande R
Capitol Peak
Fra Cristobal Range
SAN ANDRES MTNS
Salinas Peak
U.S. 54
Skillet Knob
Tularosa
Truth or Consequences
Atchison, Topeka, & Santa Fe RR
Caballo Mtns
Alamogordo
5000
6000
7000
TRINITY TEST SITE
1945
Contour interval in feet
0
20
MILES

MAP 6



Trinity Base Camp

small MP detachment under the command of Lt. Harold C. Bush arrived from Los Alamos to provide security for the satellite community. This vanguard was soon followed by a much larger group of scientists, technicians, medics, civil service personnel, and construction workers.

As 1945 unfolded, the activity of the more than two hundred camp residents intensified in a concerted effort to ready all technical facilities for the bomb test, tentatively scheduled for early summer. Under the supervision of the Project Trinity group, civilian construction crews—aided by additional construction personnel brought down from Los Alamos—built warehouses; repair shops; bomb-proof structures; an explosives magazine; a stockroom to house equipment shipped from the Hill; an unloading platform on the railroad siding at Pope, which was some 25 miles west of the site; a commissary; and more barracks. They also constructed more than 20 miles of blacktopped roads for a fleet of some one hundred motor vehicles, erected 200 miles of telephone wire, and installed electric water pumps and portable generators.

As at Los Alamos, sustaining community morale among the residents of Trinity was a continuing problem. Because of strict security requirements, no one could leave the base camp except on official missions. And as the time for the test approached, increasingly long hours of work under conditions of extreme heat and exposure to a variety of poisonous reptiles and insects added to the stress, strain, and fatigue. Hence, project leaders at Trinity made a special effort to supply good food, reasonably comfortable quarters, and a variety of recreational sports and activities. Lieutenant Bush, in particular, took a personal interest in improving morale in the community. He assumed the additional duty of making certain that adequate housing and feeding facilities were available for the expanding population, and he also provided organized athletics, local hunting trips, a game room, and nightly movies. The success of these measures is evidenced by the fact that, by mid-summer 1945, the essential technical facilities at Trinity were all ready for the crucial test of mankind's first atomic explosion.

While many times in the past the Army had to establish communities for special and unusual purposes in remote and often inhospitable places, nothing had quite prepared it for Los Alamos and Trinity. For a number of reasons, the parent community and its satellite were unique in the American experience: They assembled, for the first time, a small army of scientists and technicians in a central laboratory to achieve a single objective; they isolated this group for many months under difficult living conditions and grueling work schedules; and they functioned as a military reservation in compliance with strict security regulations. These circumstances inevitably produced some serious stresses and strains on the fabric of community life for the civilians, who were unaccustomed to the strong military direction over their civic activities. But the Army administration, working patiently and skillfully through Oppenheimer and other civilian leaders, dealt effectively with each potentially disruptive situation and succeeded in maintaining a community environment that sustained the large-scale collaborative effort between the government and science to design and test an atomic weapon.

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PART FOUR

THE BOMB

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CHAPTER XXIV

The Los Alamos Weapon Program

The ultimate focus of the Manhattan Project's manifold activities—production of fissionable materials; procurement of raw materials, manpower, and process support; establishment of security, health, and safety programs; and construction of atomic communities—was the Los Alamos Laboratory weapon program. Actively under way by the spring of 1943, its major objectives, as General Groves succinctly summarized them, were "to carry on research and experiment[s] necessary to the final purification of the production material, its fabrication into suitable active components, the combination of these components into a fully developed usable weapon, and to complete the above in time to make effective use of the weapon as soon as the necessary amount of basic material has been manufactured." [1]

Planning Phase

Whether the Army could attain the objectives of the Los Alamos weapon program greatly depended on its ability to build and operate a major scientific and engineering organization at the isolated New Mexico site. Because the technical problems corollary to bomb development were in many respects unique, few precedents existed to guide Manhattan's military and civilian scientific leaders in organizing and staffing the bomb laboratory. Hence, in carrying out these first steps of the weapon program, they adopted a generally pragmatic and *ad hoc* approach.

Efforts of Groves and Oppenheimer

Because of the need for maximum security, the atomic leaders concluded that a normal Corps of Engineers administrative organization—district engineer supervision and control, area engineer liaison and support—was not feasible at Los Alamos. For this reason, Groves himself assumed many functions of both offices. Working closely with the civilian head of the bomb laboratory, J. Robert Oppenheimer, the Manhattan commander not only exercised broad policy control over the weapon program but also regularly intervened in day-to-day operations, using telephone and teletype means of communications and frequent personal visits to main-

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[1] Quotation from Ltr, Groves to Oppenheimer, 26 Jan 44, Admin Files, Gen Corresp, 600.12 (Y-12), MDR. This description of the objectives of the Los Alamos program was a slightly amended statement taken from MPC Rpt, 21 Aug 43, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab E, MDR.

J. Robert Oppenheimer

tain surprisingly close supervision. Though his most important contact was through Oppenheimer, he also acted through the facilities of the Albuquerque District and the Los Alamos military organization, as well as through certain individual Army and Navy liaison officers assigned to the weapon program. With this administrative arrangement in effect, the role of the prime contractor, the University of California, was narrowly confined to the details of business management and procurement for the laboratory.[2]

The personal leadership of Groves and Oppenheimer was particularly evident in some of their early administrative actions. In late January 1943, Groves selected Lt. Col. John M. Harman, a Corps of Engineers officer with a degree in civil engineering, as the first commanding officer of the Los Alamos post. At the same time, he requested the War Department's Services of Supply to furnish and train military personnel for the post, specifying allotment of military police, engineer, and medical troops in time for activation of Los Alamos as a Class IV installation on 1 April 1943. In consultation with James B. Conant, he drew up a statement on the organization, function, and responsibilities of the various elements that would be located at Los Alamos, clearly delineating the division of local responsibilities between Oppenheimer, the scientific director, and Colonel Harman, the post commander. In meetings with University of California officials during February and March, Groves worked out business and procurement arrangements for Los Alamos, including establishment, for reasons of security, of the laboratory's main procurement office in Los Angeles.[3]

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[2] For a record of Groves's frequent personal interventions in Los Alamos operations see Groves Diary, Nov 1942–Aug 1945, LRG. On the limited role of the University of California see MDH, Bk. 8, Vol. 2, "Technical," p. III.6, DASA; Interv, Fine, Remington, and Ralph F. Weld with Groves, 11 Feb 64, CMH and OCEHD.

[3] *Official Army Register*, 1 Jan 44 (Harman's promotion to colonel, effective 15 Feb 43); Groves Diary, 27 and 29 Jan, 1, 13, 22–25, 27 Feb, 8, 10–12, 14–15 and 19 Mar 43, LRG; Ltr, Conant and Groves to Oppenheimer, 25 Feb 43, copy in MDH, Bk. 8, Vol. 2, App. 1, DASA; Memos, Groves to CG SOS, sub: Org and Assignment of Mil Org, 28 Jan and 22 Feb 43, Admin Files, Gen Corresp, 322 (Los Alamos), MDR; Memo, Groves to CG SOS, sub: Activation and Administration of Los Alamos, 27 Feb 43, Admin Files, Gen Corresp, 319.2 (Los Alamos), MDR; MDH, Bk. 8, Vol. 1, "General," p. 7.1, Vol. 2, pp. 1.5 and 1.9, and Vol. 3, "Auxiliary Activities," pp. 1.1–1.4 and App. A1, DASA. All Army installations in the zone of interior were classified into four categories. Class IV installations were technical in nature, such as government-owned manufacturing plants, proving grounds, and the Signal Corps Photographic Center in New York.

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Meanwhile, Oppenheimer was visiting various universities and institutions to enlist a cadre of scientists for his laboratory. But the shortage of scientific manpower, caused by the special needs of other war projects, and certain misgivings about the restrictive military character of the new laboratory hindered his initial efforts. To alleviate the scientists' doubts on this score, Oppenheimer reassured prospective recruits with a promise from Conant and Groves that, for at least the first phase of the program, the laboratory would function on a strictly civilian basis and that the staff would not be militarized until actual fabrication of a weapon began.

This approach improved Oppenheimer's recruiting efforts, especially among scientists already engaged in some aspect of atomic research. Starting with members of Manhattan's fast-neutron team—it included university scientists from California (Berkeley), Minnesota, Wisconsin, Stanford, and Purdue—Oppenheimer added other scientists from the University of Chicago's Metallurgical Laboratory, among them the Hungarian-refugee physicist Edward Teller, and from Princeton University's now discontinued program for isotopic separation of uranium. In addition, he attracted a scattering of scientists from other universities—Rochester, Illinois, Columbia, and Iowa State—and from other research organizations, including the Geophysics Laboratory at the Carnegie Institution, the Radiation Laboratory at the Massachusetts Institute of Technology (MIT), the Army's Ballistic Research Laboratory at Aberdeen, Maryland, the National Bureau of Standards, and the Westinghouse Research Laboratories in Pittsburgh.[4]

Oppenheimer and a skeleton staff of scientists arrived at Los Alamos in mid-March, despite the unfinished state of the community and technical facilities. In the ensuing months, however, there was a rapid increase in the influx of personnel, both military and civilian. By early June, Los Alamos had more than 300 officer and enlisted personnel and almost 460 civilians (160 civil service employees and 300 scientists and technicians on the University of California payroll). Finally, with sufficient personnel on hand, both the new post commander, Lt. Col. Whitney Ashbridge—Groves had relieved Colonel Harman in May because of his inability to get along with some of the scientific leaders—and Oppenheimer turned to the many problems of completing their respective organizations, especially those relating to establishment of essential coordination between the laboratory and post administrations. To guide them in this task, they had at least the initial outlines of the unfolding weapon program.[5]

The duties of commanding generals of service commands to Class IV installations were limited to specified services. See Millett, *Army Service Forces*, pp. 314-15.

[4] MDH, Bk. 8, Vol. 2, pp. I.7-I.8 and App. 1, DASA; Ltr, Conant to Groves, 26 Mar 43, OCG Files, Gen Corresp, MP Files, Fldr 23, MDR; Smyth *Report*, pp. 143-44 and 151; Hewlett and Anderson, *New World*, p. 231.

[5] MDH, Bk. 8, Vol. 1, p. 7.2 and Apps. B2 (Org Chart, Los Alamos Post Administration, 5 Jun 43) and B7 (Graph, Payroll Census Data of Los Alamos, 1942-46), and Vol. 2, p. I.11, DASA; Groves Diary, 29 May 43, LRG; Fine et al. Interv, 11 Feb 64, CMH and OCEHD.

The April Conferences

Basic planning for developing and testing an atomic weapon was the responsibility of a formal steering board, set up by Oppenheimer in late March. The board began its work in early April and conducted a series of orientation and planning conferences throughout the month. During the orientation conferences, held in the first half of the month, the board provided the newly arriving laboratory staff members with state-of-the-art information on atomic energy as a weapon of war. During the planning conferences, held in the last half of the month, the board and a group of scientific professionals reviewed the nuclear physics background and established research objectives for the weapon program. Taking part is these meetings were selected laboratory staff members, visiting consultants (Isidor I. Rabi from MIT's Radiation Laboratory and Samuel K. Allison and Enrico Fermi from the Metallurgical Laboratory), and members of a special reviewing committee.[6]

The April conferences made it very clear that what was known about the explosibility of uranium and plutonium and the design of an atomic weapon was still highly theoretical. The one area in which nuclear research had progressed significantly beyond the theoretical was in the chemistry and metallurgy of uranium and plutonium, and this had occurred only because project scientists had had to conduct extensive research into this aspect of the two elements to provide the necessary developmental data for the fissionable materials production processes at Clinton and Hanford. In virtually every other aspect essential to bomb development—the experimental physics research; the design, engineering, and fabrication of bomb components; and the assembly and testing of a weapon—the essential work remained to be accomplished. What then precisely was known in April 1943?[7]

Theoretical research had established that a single kilogram of U-235 has a potential energy release of up to 17,000 tons of TNT. To achieve this release of energy there had to be a fast-neutron chain reaction, which was theoretically possible in uranium, plutonium, and certain other elements, but most feasible in active material composed largely of the isotopes U-235 or Pu-239. A fast chain reaction could occur only with the assembly of a sufficient quantity of active material in a configuration in which natural leakage of neutrons did not occur at so high a level that the chain reaction was quenched. An important step was to design a mechanism that would provide the proper configuration for attaining criticality upon detonation. Theoretical research had already given considerable attention to weapon design, but the major problem still to be solved was how to avoid prefissioning, or predetonation.

Addressing this problem, the conferees reviewed and discussed several weapon assembly methods as possible solutions. They immediately discounted those methods that required either too much active material (as in the autocatalytic, or self-assembling, method) or employment of an atomic explosion to trigger fusion (as in a thermonuclear bomb using a mass of deuterium as the source of its energy). In their estimation the most feasible design was the gun-assembly method, comprised of a cannon in which an explosive-propelled projectile containing one portion of active material is shot through a second target containing another portion of material—thus achieving criticality.

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[6] MDH, Bk. 8, Vol. 2. p. I.11, DASA; Hewlett and Anderson, *New World*, pp. 235–36.

[7] Discussion on the state of knowledge in April 1943 is based on MDH, Bk. 8, Vol. 2, pp. I.11–I.12, DASA; Hewlett and Anderson, *New World*, pp. 232–35; Rpt, Spec Reviewing Committee on Los Alamos Proj, 10 May 43, Admin Files, Gen Corresp, 600.12 (Development), MDR; Memo, Tolman, sub: Los Alamos Proj as of Mar 43, OSRD.

The conferees were confident that the gun-assembly method, if properly engineered, would work with the isotope U-235, because of its properties; however, they were considerably less certain about its feasibility for Pu-239, partly because the continued scarcity of this isotope had limited the amount of study that could be made of its chemical and metallurgical properties. Realizing the pile method of producing Pu-239 made that substance most likely to be the active material available in the largest quantities, the conferees were especially anxious to find a design suitable for its employment. Continued discussions indicated that the implosion concept offered the best promise of success for plutonium. In a weapon of this design, a quantity of active material in a subcritical shape would be surrounded with layers of ordinary explosive in such a way that, upon detonation, the active material would be compressed into a critical configuration and the fast chain reaction would take place. Later research revealed that the implosion design would produce an effective atomic explosion using considerably less active material than the gun method—a fact especially appealing to Manhattan leaders.

The April conferences provided Groves, Oppenheimer, and other Manhattan leaders with new insight into what the immediate emphasis and direction of the weapon program must be by identifying the specific research objectives that would produce the necessary data not only for timely design and fabrication of an atomic weapon but also for an understanding of its destructive effect. First, because information on the amount of damage that would result from an atomic blast was almost totally lacking, the conferees prescribed the collection of systematic data on the likely physical, psychological, and mechanical effects of an explosion of the magnitude of an atomic bomb—realizing, of course, that part of that data would have to await an actual test of an atomic device. Second, they outlined a schedule of theoretical studies, experimental physics, and research in chemistry and metallurgy that hopefully would furnish the data needed to substantiate what was already known concerning the explosive potential of U-235 and Pu-239, to measure precisely the critical mass of each, and to prepare the fissionable and other materials to be used in an atomic weapon.

Reliable estimates by the scientists in the uranium and plutonium production programs at Clinton and Hanford indicated that sufficient fissionable material for an atomic weapon would be available in about two years. Would the Los Alamos Laboratory be able to fabricate a weapon within that time? Because the April conferences had failed to provide, except in very limited terms, concrete proposals for the organization and work of an ordnance program to carry out the actual design and fabrication of the weapon, it was to this subject that the special reviewing committee particularly addressed itself.[8]

Groves had established this committee in late March to ensure that the program and organization of Los Alamos were sound. Conant, acting as Groves's scientific adviser in organizing the bomb project, had persuaded the Manhattan chief of its appropriateness by pointing out that scientists were accustomed to having such committees at universities and research institutions to help plan and evaluate research projects. Conant and Richard C. Tolman, vice chairman of the National Defense Research Committee (NDRC), had helped Groves select the committee members: as chairman, chemist Warren K. Lewis of MIT; engineer Edwin L. Rose, who was director of research for the Jones and Lamson Machine Company; theoretical physicist John H. Van Vleck and chemist E. Bright Wilson, Jr., both from Harvard; and Tolman, who had agreed to serve as secretary. It was an experienced group, with all members except Rose already well informed on the atomic project. Lewis earlier had served as chairman of both the heavy water and DSM reassessment reviewing committees; Wilson and Tolman had been members of the heavy water group; and Van Vleck had participated as far back as 1941 in reviews of the uranium program.[9]

In its report issued on 10 May, the special reviewing committee endorsed most of the program discussed in the April conferences, outlining what it believed must be done in the way of theoretical and experimental work on the critical mass, efficiency of an explosion, and damage potentialities. Placing primary emphasis on the ordnance and engineering aspects of bomb development, the committee recommended that the laboratory expand the personnel and facilities needed to design and fabricate a weapon; it foresaw that the engineering program would more than double the personnel of the laboratory and require extensive facilities to test weapon components, and also that arrangements would have to be made with the Army Air Forces for assistance in bomb design and tests. The committee further recommended that the purification of Pu-239 "be made a responsibility of the Los Alamos group, not only because they must be responsible for the correct functioning of the ultimate weapon, but also because repurification will be a necessary consequence of experimental work done at the site." This activity, hitherto centered at the Metallurgical Laboratory, would require a substantial increase in personnel and facilities.

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[8] MDH, Bk. 8, Vol. 2, pp. 1.11-1.12, DASA; Groves Diary, 30 Apr and 1 May 43, LRG; Hewlett and Anderson, *New World*, pp. 233-36.

[9] Memo, Maj Harry S. Traynor (MD HQ) to Groves, 28 Apr 45, Admin Files, Gen Corresp, 334 (List of Committees), MDR. Ltr, Tolman to Groves, 20 Mar 43; Duplicate Ltrs, Groves to Lewis, Rose, Wilson, and Van Vleck, 21 Mar 43; Rpt, Spec Reviewing Committee on Los Alamos Proj, 10 May 43. All in Admin Files, Gen Corresp, 600.12 (Development), MDR. MPC Min, 30 Mar 43, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR. Hewlett and Anderson, *New World*, pp. 36, 104, 110, 235-36. See also Ch. V.

Consistent with its recommendations for expansion of the program, the reviewing committee also proposed appropriate organizational and administrative changes. While it was highly commendatory of Oppenheimer, it recommended that he should be provided with more administrative assistance in his immediate staff. It suggested appointing an associate director, capable of taking over direction of the project when Oppenheimer was absent, and establishing an administrative office, headed by a civilian who could maintain good working relations with the military administration.

The only aspect of the program's administrative arrangements receiving severe criticism was procurement. While the Los Alamos procurement office appeared to be functioning reasonably efficiently, the key office in Los Angeles, under Army direction but manned largely by University of California personnel, was following procedures that were "unduly slow and cumbersome." The delays could not be allowed to continue, because "not only the satisfactory progress of the work, but also the morale of the organization is dependent on an efficiently functioning procurement system." A partial solution, the committee suggested, would be to establish a procurement office in New York for obtaining supplies and equipment from firms in the eastern part of the United States.[10]

Laboratory Administration

The recommendations of the April conferences and the special reviewing committee did not alter the basic plan for operation of Los Alamos, as worked out by Groves, Conant, and Oppenheimer in early 1943, but entailed a considerable expansion of the weapon program and support personnel. With these new guidelines, Groves and Oppenheimer set about to complete the organization of the laboratory and its administrative and technical staffs.

Administrative Organization

A number of factors complicated Oppenheimer's task of forming a laboratory administration capable of maintaining the required liaison with the post administration, the necessary communication with other Manhattan District organizations, and effective control over the increasingly complex engineering activities of the bomb development program. One was security, particularly the requirement for compartmentalization, which placed severe limitations on communication within the laboratory, between the scientific and military organizations and between the laboratory and outside agencies. Another was the acute shortage of professional personnel experienced in dealing with the broad administrative problems of a research laboratory. A third factor was the lack of precedents to follow in organizing a laboratory staff for a program that ran the gamut from pure scientific research to the actual performance of ordnance manufacturing operations. The combined effect of these factors was to place an unusually heavy administrative burden on the laboratory director and his immediate supervisory staff.[11]

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[10] All quotations in discussion of committee's recommendations from Rpt, Spec Reviewing Committee on Los Alamos Proj, 10 May 43, MDR. The Military Policy Committee heard an oral summary (probably by Groves) of the principal recommendations of the report at its meeting on 5 May 43. See MPC Min, 5 May 43, MDR.

Both Groves and Oppenheimer had been aware of the need for a strong administrative group in the director's office, but their efforts in that direction had not been very successful. Their first choice for associate director was physicist Edward U. Condon from Westinghouse. Condon came in April 1943, but left almost immediately when he found himself in complete disagreement with security arrangements. As an experienced scientific administrator, he perceived the fundamental difficulty of trying to maintain essential liaison within the laboratory and with outside agencies under the project's security system.[12]

With the strongly worded recommendations of the reviewing committee still very much on his mind, Oppenheimer immediately sought to replace Condon, as well as to fill the other key positions on his administrative staff. He was generally frustrated, however, in his efforts to recruit professionally trained, experienced scientific administrators. They simply were not available. He appointed a staff assistant to carry on the absolutely essential day-to-day liaison with the post administration, pending recruitment of a new associate director, but this position as originally conceived was destined never to be filled. In other key positions, he had to be satisfied with either scientists with little previous administrative experience or administrators with appropriate experience in nonscientific fields (for example, construction or business administration). Two of his appointees were physicists Dana P. Mitchell and Arthur L. Hughes, both of whom had no administrative experience in industry. Mitchell, selected to be procurement director, had been in charge of procurement for the physics department at Columbia University; Hughes, selected to be personnel director, previously served as chairman of the physics department at Washington University in St. Louis.

To assist Hughes with the ever-constant manpower problem, Oppenheimer enlisted the services of Brown University Dean Samuel T. Arnold, who was serving as a technical personnel consultant for the project, to recruit senior scientists and M. H. Trytten of the National Roster of Scientific and Specialized Personnel to recruit junior scientists and technicians. But the very nature of Los Alamos personnel requirements seemed to resist all attempts at a satisfactory solution, and Groves became convinced by the summer of 1944 that Hughes was not capable of solving the problem. The Manhattan commander took immediate action: He offered the position of personnel chief to Dean Arnold. Arnold demurred but agreed to go on a temporary basis until a replacement could be found. Eventually, on the basis of Arnold's recommendation, Hughes was replaced with astronomer Charles

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[11] MDH, Bk. 8, Vol. 2, pp. I.33 and III.8–III.9, DASA.

[12] Ltr, Condon to Oppenheimer, 26 Apr 43, Investigation Files, Gen Corresp, Personnel Scty Investigations (Condon), MDR; Groves, *Now It Can Be Told*, pp. 154–55 (see reprint of 26 April letter on pp. 429–32); MDH, Bk. 8, Vol. 2, pp. III.7–III.8, DASA. See Ch. XI for more details on Condon's departure from Los Alamos.

D. Shane, who had been working at the Radiation Laboratory in Berkeley.

It was mid-1944 before Oppenheimer had found suitable personnel for all positions—an administrative officer; heads of personnel, procurement, business, and patent offices, as well as of a health group, a maintenance section, and a library-documents room; and also an editor. He finally rounded out his administrative staff with appointment of a shops section chief in late 1944 and a safety group head in early 1945.[13]

Technical Organization

The technical organization of the laboratory took shape along the lines of the expanded program of research and development, as recommended in the April conferences and reviewing committee report. There were separate divisions for theoretical physics, experimental physics, chemistry and metallurgy, and ordnance. Within each division were a number of working groups or teams, each devoted to a particular aspect of bomb research or development. For example, the theoretical division had a diffusion problems group; the ordnance division had an implosion experimentation group; and the chemistry and metallurgy division had a uranium and plutonium purification group. Leaders of the groups reported to their division leaders and the division heads reported directly to Oppenheimer. As the work of the laboratory progressed, groups completed their projects and disbanded, and new groups formed to take up investigation of new problems.[14]

To direct the complex activities of the laboratory's technical divisions, Oppenheimer relied chiefly upon the assistance and advice of a governing board and a coordinating council. The governing board, comprised of seven to ten administrative and technical staff heads, began as an advisory group but gradually evolved as a policy and decision-making body, its primary function being to assist Oppenheimer in coordinating the various scientific and engineering facets of the weapon program. Unlike the governing board, the coordinating council did not ordinarily concern itself with policy. Comprised of scientists and technicians who were group leaders or higher, the council provided a channel of communication between the second-level staff and the governing board and primarily functioned as a forum for interchange of information and opinion on current developments in the various divisions.[15]

Keeping the staff scientists abreast of the work going on in the various technical divisions, in Oppenheimer's opinion, was indispensable to the success of the weapon program. To facilitate this situation, Oppenheimer, with approval of the governing board, established in May 1943 a weekly colloquium for all laboratory staff members. General Groves had accepted the coordinating council as a necessary risk to security, but when he heard of the colloquium, he immediately protested to Oppenheimer that he considered it to be a "major hazard." Oppenheimer defended the colloquium as an effective tool: Giving the scientific staff adequate information, he believed, would actually enhance security, for the scientists would achieve a better understanding of the necessity for secrecy. Groves decided to defer to Oppenheimer's wishes and let the colloquium continue, having concluded that the most important reason Oppenheimer wanted a colloquium was not to provide information but "to maintain morale and a feeling of common purpose" in his scientific staff.[16]

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[13] MDH, Bk. 8, Vol. 2, pp. II.4, III.7–III.9, III.17, III.57, IX.10, IX.19–IX.23, DASA; Ltr, Hughes to Arnold, 15 Jan 44, Admin Files, Gen Corresp, 201 (Gen), MDR; Groves, *Now It Can Be Told,* p. 154, n. 2; Defense Atomic Support Agency (DASA) Hist, App. B (List of Manhattan Proj Committees), CMH; Groves Diary, 18 May, 14, 16–17, 20, 23, 26, 29–30 Jun, 3–5 and 10 Jul 44, LRG.

[14] MDH, Bk. 8, Vol. 2, pp. III.1 and IX.1, DASA; DASA Hist, App. B, CMH; Hewlett and Anderson, *New World,* pp. 237 and 310–12.

[15] MDH, Bk. 8, Vol. 2, pp. III.1–III.3 and IX.1–IX.7, DASA; DASA Hist, App. B, CMH; Hewlett and Anderson, *New World,* pp. 237–38 and 310–12; Groves, *Now It Can Be Told,* pp. 159–61.

The Military Policy Committee supported Groves's views concerning the potential security risk of the Los Alamos colloquium. Seeking a solution to the broader issue of which the colloquium was symptomatic—how to bolster the morale of all project scientists by getting them to accept the necessity for security restrictions—the committee decided that the problem was sufficiently serious to warrant using its trump card, a letter from the President himself to the scientists. In late June, OSRD Chairman Vannevar Bush took advantage of an appointment with Roosevelt to secure his approval for the proposed letter. The President agreed enthusiastically, and Conant drafted an appropriate communication for Roosevelt's signature.[17]

At the July meeting of the colloquium, Oppenheimer read the President's letter to the assembled scientists. The scientists, as a staff member subsequently recalled, seemed much encouraged by the President's expression of satisfaction with their "excellent work" thus far, his assurance that the atomic project was of great significance to the war effort, and his indication of confidence in their "continued wholehearted and unselfish labors" toward successful completion of the project. They also appeared to listen attentively to the President's explanation of why "every precaution [must] be taken to insure the security of your project," and his assumption that they were "fully aware of the reasons why their endeavors must be circumscribed by very special restrictions." Although the presidential letter undoubtedly achieved its twofold purpose, Oppenheimer chose not to regard it as a directive to discontinue the colloquium. But he did carefully screen those permitted to attend it and otherwise tightened security arrangements for its sessions.[18]

Manhattan's original concept that Los Alamos should function in complete isolation obviated the laboratory's having any regularly established channels of communication with other Manhattan District or outside organizations. Consequently, whenever the laboratory required technical information from these sources, it had to obtain special permission from General Groves's Washington office. This *ad hoc* system remained the basic policy throughout the war, although Groves had to grant some limited exceptions to it. For example, in June 1943, he allowed Los Alamos scientists not only to correspond but also to visit certain members of the Metallurgical Laboratory to secure specified data on fissionable materials and other chemicals. And again in November, he consented to let Oppenheimer make a one-time visit to the Clinton plants after the governing board at Los Alamos had indicated repeatedly that there were going to be serious delays if someone at the laboratory did not secure information on the production schedules for fissionable materials.[19]

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[16] Quoted words from Groves, *Now It Can Be Told*, p. 167. See also MDH, Bk. 8, Vol. 2, pp. III.3–III.4, DASA; *Oppenheimer Hearing*, pp. 166–67; Hewlett and Anderson, *New World*, p. 238.

[17] MPC Min, 24 Jun 43, MDR; Memo for File, Bush, sub: Conf With President, 24 Jun 43, OSRD; Hewlett and Anderson, *New World*, pp. 238–39. The President's letter received mixed reactions from Metallurgical Laboratory scientists. See Ch. IX.

[18] Quoted phrases from Ltr, Roosevelt to Oppenheimer, 29 Jun 43, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab D, MDR. See also MDH, Bk. 8, Vol. 2, pp. III.7, DASA. David Hawkins, the author of this account of the wartime history of the Los Alamos Laboratory, regularly attended meetings of the colloquium as a special assistant on Oppenheimer's staff.

The project's security system was again severely tested in early 1944, when a reorientation of the weapon program from theoretical and experimental research to ordnance and engineering problems necessitated increased liaison between Los Alamos and outside agencies. With strict compartmentalization still in effect, many of the laboratory staff members who required liaison with civilian agencies resorted to a variety of clandestine devices, such as using blind addresses and NDRC identifications and requesting technical reports through Tolman's NDRC office in Washington, D.C. Security barriers were less formidable with other military elements, including the Army's Ordnance Department, the Navy's Bureau of Ordnance, and the Army Air Forces.[20]

The weapon program reorientation provided Oppenheimer with an opportunity to form a more effective laboratory administration and organization in mid-1944. Aware of Groves's general dissatisfaction with the existing organization, Oppenheimer realigned the administrative and technical components of the laboratory to reflect the new emphasis on engineering and ordnance development of atomic devices and, more particularly, on solution of the still formidable problems of implosion.[21]

One goal of the reorganization was to realign the scientific leadership of the laboratory so that its efforts were brought to bear on the most urgent phases of bomb development. By abolishing the governing board and dividing its functions between an administrative and a technical board, Oppenheimer eliminated unnecessary diversion of scientific leadership into housekeeping activities. A series of special conferences and committees to supervise particular aspects of bomb fabrication and testing ensured concentration of effort on key problems. The intermediate scheduling conference, which began meeting in August 1944, coordinated work of those laboratory groups primarily concerned with the implosion bomb. The technical and scheduling conference, organized in December, undertook responsibility for programing experiments, use of shop time, and employment of active materials. The cowpuncher committee, so designated by laboratory officials because it was established to "ride herd" on implosion, met for the first time in March 1945. Other committees supervised weapon testing, procurement of detonators, scheduling of experiments with U-235, and development of initiators for implosion devices.

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[19] MDH, Bk. 8, Vol. 2, pp. III.4–III.5, DASA; Memos, Groves to Compton and Oppenheimer, 17 Jun 43, and Oppenheimer to Groves, 4 Oct 43, OSRD..

[20] MDH, Bk. 8, Vol. 2, pp. III.5–III.6, DASA.

[21] Except as otherwise stated, discussion of Los Alamos reorganization is based on MDH, Bk. 8, Vol. 2, pp. IX.1–IX.7, DASA; DASA Hist, App. B, CMH; Hewlett and Anderson, *New World*, pp. 310–12 and 317–19.

Both Conant and Groves realized that Oppenheimer was faced with complex industrial problems, yet he lacked an industrial expert on his staff to advise him on these problems. Consequently, in November 1944, Groves recruited the services of Hartley Rowe of the United Fruit Company, an outstanding industrial engineer who also had served with the NDRC and as a technical adviser to General Eisenhower, Supreme Commander, Allied Expeditionary Force. Rowe spent considerable time at Los Alamos in late 1944 and early 1945, guiding the technical divisions in the development of the procedures by which laboratory models could be converted into production units—the final phase in the weapon program.[22]

Oppenheimer's reorganization directly impacted on the makeup and character of the laboratory's technical divisions, transforming their focus from problems of research and experimentation to those relating to engineering and fabrication of the bomb. When measurement of the fission rate of plutonium indicated it could not be used in a gun-type bomb, technical activities shifted to development of an implosion-type bomb. Oppenheimer created new divisions and reduced the size of several of the older divisions. The theoretical and research divisions were retained, but most personnel and facilities were funneled into the ordnance, weapon physics, explosives, and chemistry and metallurgy divisions. In the spring of 1945, with fabrication of atomic devices proceeding apace, Oppenheimer established new off-site testing divisions: Project Alberta, to carry out all activities related to combat delivery of both the gun assembly and implosion bombs; and Project Trinity, to test-fire the first implosion bomb. While the new divisions comprised integral parts of the laboratory organization, division field teams from Los Alamos assembled and tested the various components of the weapons at other sites.[23]

Post Administration

The wartime character of the Los Alamos post administration—its organization and personnel composition—directly reflected the course of the bomb development program. Thus, when Colonel Harman began to organize the post in the spring of 1943, he was guided by the then existing plans for a small technical laboratory with a supporting community of no more than a few hundred civilian and military personnel, but requiring an extraordinary degree of protective security and self-sufficiency. The modest organization he formed for this purpose was comprised of three major divisions. The Administrative Divison looked after civilian personnel matters, provided various means for internal and external communications, maintained essential records, and audited post accounts. The Protective Security Division furnished post security and administered the military units assigned to Los Alamos, including Military Police (MP) and Provisional Engineer Detachments (PED). The Operations Division provided and maintained most of the community services—housing, utilities, commissary, and education and recreation facilities—in cooperation with the laboratory's community council. Finally, a small, semiautonomous procurement group performed quartermaster functions; monitored contracts; and supervised property and warehouse operations, including the important Santa Fe receiving facility for laboratory shipments from the Los Angeles procurement office.[24]

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[22] Groves Diary, 12, 26 Oct, 9 Nov 44 and 11, 20 Jan 45, LRG; Rowe to Capt John A. Derry (of Groves's office), 13 Nov 44, Admin Files, Gen Corresp, 201 (Hartley Rowe), MDR; *Oppenheimer Hearing*, pp. 508–09.

[23] For further details on the organization and location of Project Trinity see final section of Ch. XXV. Lansing Lamont's *Day of Trinity* provides a popular account. On Project Alberta see MDH, Bk. 8, Vol. 2, pp. IX.6–IX.7 and XIX.1–XIX.13, DASA. The account in MDH is based upon Ms, Norman F. Ramsey, "History of Project A[lberta]," Incl to Ltr, Ramsey to Brig Gen Thomas F. Farrell (MD Dep Cdr), 27 Sep 45, LASL.

Personnel for the original post organization began arriving on the Hill in late April 1943. By early June, Colonel Ashbridge, who had just replaced Harman as post commander, had a staff of 18 officers (including 1 WAAC officer). This staff directed the activities of slightly over 450 military and civilian personnel. There were more than 200 enlisted men in the MP unit, including attached medical and veterinary personnel; 85 enlisted men in the PED unit; 7 WAAC enlisted women; and somewhat fewer than 160 civil service employees. To meet increased demands for post services and support in the ensuing months, Ashbridge obtained additional PED and MP personnel from the 8th Service Command headquarters in Dallas. And with General Groves's assistance, additional civil service and military personnel were procured through Corps of Engineers and other channels—for example, the Army Specialized Training Program (ASTP), which furnished enlisted men with scientific and technical skills.[25]

Military personnel with scientific and technical training were assigned to the Manhattan District's Special Engineer Detachment (SED), 9812th Technical Service Unit; the latter unit was a special engineer organization formed at District headquarters to retain scientific and technical employees subject to the draft and to recruit additional technically trained personnel for the project. Los Alamos began receiving SED personnel in August 1943 and, because of Groves's personal intervention, periodically thereafter. SED members worked at technical jobs for the laboratory, but were assigned to the post administration for rations and quarters.

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[24] MDH, Bk. 8, Vol. 1, pp. 6.1–6.2 and App. B2, DASA. See Ch. XXIII for a detailed discussion of the administration of community affairs at Los Alamos.

[25] Statistics in this and the following paragraphs on military and civilian personnel assigned to the Los Alamos post in 1943 are based on MDH, Bk. 8, Vol. 1, pp. 7.3–7.15 and Apps. B2–B3 (Org Charts, Los Alamos, 5 Jun and 5 Dec 43), and Vol. 2, p. III.18 and App. Graph No. 2 (Number of Persons Employed: Distribution Among Civilians, WAC, and SED), DASA; List, sub: MD Offs on Duty at Los Alamos and Their Duties, 6 May 44, Incl to Memo, Ashbridge to Groves, 14 Jun 44, Admin Files, Gen Corresp, 201 (Gen), MDR; Groves Diary, 25 Aug and 3 Sep 43, LRG. See Ch. XVI for information on the 8th Service Command's provision of troops for the atomic project and on the ASTP, as well as on the formation of the 9812th and the SED.

By the end of the year, total personnel assigned to the post administration approached 1,100. The largest numerical increase was in civil service employees, nearly 450 as compared with some 160 in June. Increases in the military complement were more moderate. The number of MP's grew from 190 to 300 and that of PED's from 85 to around 200. With the establishment of a regular WAC Detachment at Los Alamos, the number of enlisted women was increased from 7 to 90. And because of the assignment of recent ASTP graduates to Los Alamos, SED strength figures increased from 300 to about 475.

Even with expansion of bomb development activities and its concomitant increases in post personnel, the basic structure of the post administration remained essentially the same, with only the Operations Division undergoing a moderate reorganization. In early 1944, when Manhattan assumed responsibility for all further construction and maintenance activities at Los Alamos, Colonel Ashbridge strengthened the operating capability of the Operations Division by reorganizing it into two major sections—one for community construction and maintenance, the other for technical area work—and by recruiting more carpenters, bricklayers, plumbers, painters, electricians, and common laborers.

Increased demands for new technical-type construction soon outran the capabilities of the division, so Manhattan engaged another professional construction contractor, Robert E. McKee of El Paso. In spite of this major change, Colonel Ashbridge decided to retain the dual organization of the division, which had the security advantage of limiting access to the sensitive technical area to one group of workmen. But in early 1945, with the decision to retain McKee on a permanent basis to perform construction services at Los Alamos, the new post commander, Col. Gerald R. Tyler, rejected the dual organization and reverted to a unified structure. In this reorganization, which remained in effect until after completion of the wartime program, Tyler set up separate sections for contractor construction and administration, post construction and maintenance, and post engineer services.[26]

The Army's principal role at Los Alamos, as well as elsewhere in the Manhattan Project, was ensuring effective administration and operational efficiency. In the main, this was achieved through the personal cognizance and direct action of the post commander. As the military administrator, the post commander played a key role in arranging military deferments for technical employees of the University of California, which included most of the scientists and technicians, and in monitoring the shipments of fissionable materials to Los

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[26] MDH, Bk. 8, Vol. 1, pp. 5.6–5.11, 7.2, 7.13–7.14, App. B4 (Org Chart, 1 Feb 45), DASA; Fine and Remington, *Corps of Engineers: Construction*, pp. 697–700. Tyler replaced Ashbridge in late 1944, when the latter's health began to fail under the strain of the demands placed upon him as Los Alamos post commander (see Groves Diary, 28 Oct and 2, 14, 25 Nov 44, LRG).

Alamos and the transmission of documents containing technical information from other parts of the Manhattan District. Coincident with his general supervision of post procurement and construction and maintenance activities, he consulted with key members of the laboratory administration, especially Oppenheimer and Capt. William S. Parsons, the naval gunnery officer in charge of the laboratory's ordnance group. These consultations increased in frequency as program emphasis shifted from theoretical and experimental research to ordnance and engineering problems and requirements expanded for construction of new technical facilities and procurement of additional materials and equipment.[27] Factors endemic to the atomic project, however, presented major obstacles to achievement of an efficient procurement system at Los Alamos. Among these were the atomic reservation's location, more than a thousand miles from any major market and distribution center; security requirements that necessitated time-consuming, roundabout routing of the bulk of procurement through Los Angeles and elsewhere; and the highly technical and often unique character of many of the items to be procured. Another factor was the University of California's insistence that all matters of purchasing and payments must be administered directly by members of the university business staff. But because the Army would not permit university employees at Los Alamos, the project located its main purchasing office in Los Angeles.[28]

In the face of these obstacles, Groves, Lt. Col. Stanley L. Stewart of the Los Angeles procurement office, and Army procurement personnel at Los Alamos worked with University of California officials to increase procurement efficiency. Groves maintained direct and frequent contact with the Los Angeles Area Engineers Office, established in early 1943 to supervise University of California procurement personnel. He sanctioned the opening of branch purchasing offices in New York and Chicago to provide the laboratory with direct access to eastern markets, saving time and reducing paperwork for the Los Angeles office. Army and laboratory procurement officials at Los Alamos worked out an arrangement for requisition of certain available items locally through the post supply organization.

As the volume of required materials increased dramatically in late 1944, Groves authorized a request by the laboratory's ordnance division to set up a separate procurement group. The Army officer supervising this new procurement channel maintained an office in Detroit, which was an important source for many of the bomb components. He also made frequent use of the California Institute of Technology's experienced procurement personnel at its Project Camel site. In spite of all these efforts, the flood of last-minute requisitions for the implosion weapon test in the spring of 1945 created threatening delays. Oppenheimer convened an emergency meeting of project procurement officials at Los Alamos, and they agreed to increase procurement personnel and salaries, to establish direct communications between the New York and Chicago offices, and to require improved drawings and specifications in requisitions from the laboratory.[29]

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[27] List, sub: MD Offs on Duty at Los Alamos and Their Duties, 6 May 44, Incl to Memo, Ashbridge to Groves, 14 Jun 44, MDR; DASA Hist, App. B, CMH; Fine and Remington, *Corps of Engineers: Construction*, pp. 697-700.

[28] MDH, Bk. 8, Vol. 2, pp. III.27-III.34, and Vol. 3, "Auxiliary Activities," pp. 1.1-3.3 and Apps. A1-A2, DASA.

The reorientation and expansion of bomb development activities eventually created more and more opportunities for a surprisingly large number of the military personnel assigned to the post administration to contribute directly to the technical side of the weapon program. A number of WAC enlisted personnel, for example, moved from strictly clerical jobs in the laboratory to technical work, when scientists found they had the requisite skills or training. Similarly, several officers on the post commander's staff came to devote most of their time to essentially scientific and technical work. The post legal officer in the Administrative Division, Capt. Ralph C. Smith, found that his principal assignment was solution of patent problems, and several engineer officers who happened to have the necessary training or background in chemistry, metallurgy, or physics worked extensively with scientists and technicians in the laboratory. Other post staff officers worked full time in the development and administration of outlying test areas. Maj. Wilber A. Stevens, for example, who began in 1943 as head of the Operations Division, eventually was spending all his time supervising projects at outlying sites; acting as a liaison officer between technical and military personnel; and assisting in coordinating the work of group leaders in the laboratory. Stevens's subordinate, Captain Davalos, the post engineer heading the division's Technical Area Section, also became deeply involved in the complexities of the technical program in the course of helping to plan and carry out construction and maintenance for the laboratory.[30]

The post commander, too, tended to be drawn into more and more direct concern with technical problems. In the earliest period, lack of adequate liaison and General Groves's policy of dealing personally with the technical program had excluded the post commander from knowledge or participation. Gradually, however, Colonel Ashbridge and members of the laboratory staff developed avenues for more effective liaison. Oppenheimer's May 1943 appointment of a special assistant on his staff to take responsibility for liaison with the post administration had opened one avenue of communication, and Ashbridge's assignment to membership on the laboratory's administrative board in July 1944 provided further opportunity for the post commander to keep informed of developments in the technical program.

General Groves, with the support of his Washington staff, continued throughout the war to be perhaps the single most effective liaison channel

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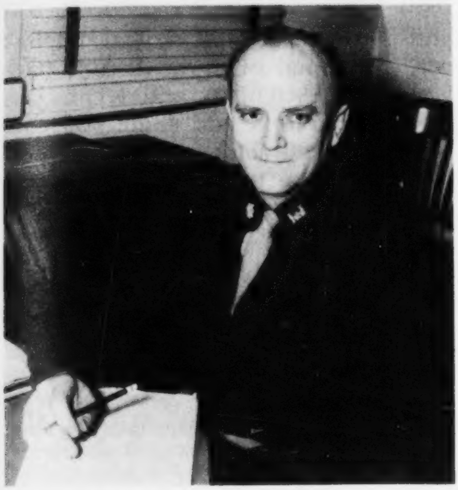
[29] Ibid., Vol. 2, pp. III.29–III.35, IX.8–IX.9, IX.13–IX.14, and Vol. 3, pp. 2.8–2.9, DASA; Groves Diary, Jul 44, 2 Nov 44, 26 Apr–May 45, LRG; Ltr, Oppenheimer to Bush, 21 Nov 44, Admin Files, Gen Corresp, 600.12 (Research), MDR.

[30] List, sub: MD Offs on Duty at Los Alamos and Their Duties, 6 May 44, Incl to Memo, Ashbridge to Groves, 14 Jan 44, MDR; MDH, Bk. 8, Vol. 1, pp. 7.5 and 7.12, and Vol. 2, pp. VII.1, VII.9, XVI.1–XVI.2, DASA.



Lt. Col. Curtis A. Nelson

between the laboratory and post administrations at Los Alamos. By frequent telephone calls to Oppenheimer, Ashbridge (later Tyler), and Parsons, as well as to Colonel Stewart in Los Angeles, the Manhattan commander kept in close touch with both community and technical developments. As with other key installations of the Manhattan Project, Groves supplemented his telephone calls with teletype messages, memorandums, and, about once every two or three months, an inspection and consultation visit lasting two or three days. In addition, Parsons visited Groves in his Washington office about once a month and Oppenheimer, Ashbridge, and Stewart less frequently.[31]

To facilitate overall administration and operation of the weapon program, Groves took special interest in matters of security, construction, and materials and manpower procurement. Of note are his personal efforts to expedite manpower recruitment for Los Alamos. In October, for example, following Conant's expression of alarm at the continuing deficiencies in the senior scientific staff, Groves worked out with a reluctant Compton for the transfer of about fifty Metallurgical Project physicists. At the same time, he brought pressure upon the District's Personnel Division chief, Lt. Col. Curtis A. Nelson, to maintain a flow of junior scientists for the laboratory's SED unit. His prodding of Nelson proved effective, for by early 1945 nearly half the working personnel on the Hill was in uniform. Groves's frequent pleas to manpower authorities in Washington to supply the New Mexico installation with more skilled workmen, especially machinists, were less productive. Hence, when Oppenheimer uncovered an opportunity in late 1944 to establish a liaison with the California Institute of Technology's well-manned Navy rocket development group in Pasadena, Groves personally intervened to expedite an arrangement with the Navy's Bureau of Ordnance that made, under a newly created Project Camel, both skilled workers and surplus facilities available to the laboratory.[32]

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[31] Groves Diary, Jan 44–Jul 45, LRG. For example, see specifically entries for 14 Mar and 18 and 24–26 May 44 (visits by Oppenheimer and Parsons to see Groves in Washington, D.C.) and 11 Dec 43, for his involvement in details of administration. For Groves's correspondence with Oppenheimer on the more technological aspects of the bomb development program see MDR, Admin Files, Gen Corresp, 400.17 (Mfg-Prod-Fab) for entries during the November 1943–August 1944 period.

[32] MDH, Bk. 8, Vol. 2, p. IX.11, DASA; Groves Diary, 16 Oct, 25, 28 Nov, 1, 5–6, 12, 27, 30 Dec 44 and 1, 3, 5, 25–26 Jan, 5–9 Feb, 3 Aug 45, LRG;

Continued

Although manpower conditions remained less than satisfactory throughout the war, the Manhattan commander's efforts directly contributed in some measure to relieving personnel deficiencies at Los Alamos. Thus in the summer of 1945, the number of post personnel continued to increase, though not at a significant rate. The SED unit had about 1,400 enlisted personnel by July. Others in the post administration numbered 1,260 8th Service Command troops (500 MP's, 500 PED's, 260 WAC's) and more than 2,000 civilian employees. This total of more than 4,900—with 1,300 scientists and technicians at the laboratory and some 500 construction contractor personnel—gave Los Alamos a total working population of approximately 6,700. At this juncture, as the bomb development program moved rapidly toward the actual test of an atomic device, all at Los Alamos were concentrating their efforts on the technical preparations for this climactic event.[33]

Ltr, Conant to Bush, 20 Oct 44, OSRD; Ltrs, Oppenheimer to Bush, 21 Nov 44, and Groves to Stewart (Los Angeles), sub: Assignment of Liaison Off for OSRD Contract OEM sr-418 w/CIT, Pasadena, Calif., 16 Jan 45, Admin Files, Gen Corresp, 600.12 (Research), MDR; Hewlett and Anderson, *New World*, p. 315. See Ch. XVI on transfer of physicists from the Metallurgical Project.

[33] See Ch. XVI for the basis of these population statistics. An official historical account of the project written in 1947 estimated total population of Los Alamos in December 1944 as 5,675 and at the end of 1945 as 8,200. See MDH, Bk. 8, Vol. 1, p. 7.15 and App. B7, and Vol. 2, App. Graph No. 2, DASA, and Groves Diary, 17 Jan 44, LRG.

CHAPTER XXV

Weapon Development and Testing

A watershed in the development of nuclear science was the Army's building and testing of the atomic bomb. In early 1943, with America engaged in what was believed to be a desperate race with Germany, American and foreign-born physicists, chemists, metallurgists, and engineers, as well as military technical experts, came together at Los Alamos to devise a weapon with a power hitherto unmatched by man. This practical objective melded with the larger scientific challenge of turning atomic theory into a material reality and resulted in a unity of purpose that sustained the assembled scientists in their unique atomic adventure.

Organized by Oppenheimer into specialized research and technical divisions and groups, the Los Alamos scientists divided their efforts between two fundamental tasks: solving the theoretical and experimental problems of a fission bomb,[1] and working out the complex ordnance and engineering problems of weapon design and fabrication. Their concentrated activity over a two-year period, from 1943 to 1945, transformed the laboratory, for all intents and purposes, into a weapon assembly and test plant. The climax was Project Trinity, the crucial test of their creation: the first atomic bomb.

Building the Bomb

By the fall of 1943, with the laboratory's administrative organization largely worked out and the scientists' talents and energies channeled into various research programs, Oppenheimer, Groves, Conant, and the other project leaders turned their attention to the problem of determining the most suitable design of an atomic device.[2] During inspection visits to Los Alamos, Groves found that some of the scientific staff members, including Captain Parsons, strongly favored the gun rather than the implosion principle as more feasible for developing a usable fission weapon. They pointed out that the well-established mechanical techniques of the gun made this weapon type almost certain to work if properly designed and that the design and engineering of the outer configuration and mechanics of the gun were already well advanced. Furthermore, once the physicists, chemists, and metallurgists could provide the precise nuclear specifications for the active material—whether U-235, Pu-239, or even U-233 from thorium—development of a workable gun-type weapon would be only a matter of time.

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[1] By late September 1943, Oppenheimer and his scientific staff definitely had decided to concentrate the laboratory's major resources on developing a fission bomb, relegating work on the "super" (or fusion) bomb to theoretical investigations by a small group of scientists under the leadership of physicist Edward Teller and then, in 1944, physicist Enrico Fermi. Both Groves and Richard C. Tolman, the Manhattan commander's chief adviser on weapon development, supported this action to carry on super bomb research even in the most hectic period of fission bomb development, primarily because they could not forget the known interest of the Germans in deuterium (heavy water)—the active material for the super bomb. See Groves Diary, 29–30 Sep 43, LRG; Groves, *Now It Can Be Told*, p. 158; Edward Teller and Allen Brown, *The Legacy of Hiroshima* (Garden City, N.Y.: Doubleday and Co., 1962), pp. 38–40; MDH, Bk. 8, Vol. 2, "Technical," pp. XIII.1–XIII.10, DASA.

[2] Except as otherwise indicated, the discussion on weapon development is based on MDH, Bk. 8, Vol. 2, pp. IV.1–VIII.32 and X.1–XVII.22, DASA, and Hewlett and Anderson, *New World*, pp. 240–54 and 310–21.

Assessment of precise nuclear specifications for a fission weapon was the responsibility of the laboratory's experimental physics division. Through intensive research, the division's physicists gathered considerable data on the effect of cosmic rays on fissioning, on measurement of nuclear cross sections, on scattering phenomena, and on other aspects of the fission process that related to bomb specifications and efficiency. With this data they were able to calculate by the summer of 1944 that the destructive effect of either an implosion- or gun-type bomb would justify the effort required to fabricate it. They still lacked an answer, however, to the question on which the success of the entire project hinged: How much fissionable material would be needed for an effective weapon? Whether or not atomic weapons would be available for use in the war depended on the answer to that question.[3]

One way to increase the efficiency of a fission bomb was to achieve maximum purity in the active materials. Hence, a major program of the laboratory's chemistry and metallurgy division was to improve the methods for purifying U-235 and Pu-239. Because purity requirements for uranium were about one-third less than those for plutonium and because, until early 1944, there was not enough Pu-239 available to permit effective work on its purification, the chemists experimented with uranium but with the purpose of developing techniques that might also be used with plutonium. When sufficient amounts of Pu-239 arrived from the Clinton pile, the chemists developed both wet and dry purification processes. Subsequently, they employed the more satisfactory wet process in final purification of most plutonium for the bomb.

Before U-235 or Pu-239 could be used in a fission bomb, they had to be converted into metal of the proper configuration and purity. Metallurgists at Los Alamos faced a number of problems in making uranium or plutonium metal of the desired quality, including the tendency of uranium to catch fire during processing and the difficulty of handling the highly reactive and poisonous plutonium. For forming uranium into metal, they experimented with electrolytic and centrifuge processes but finally settled upon a modification of the stationary

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[3] MPC Rpt, 21 Aug 43, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab E, MDR; ibid., 4 Feb 44, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab C, MDR.

TECHNICAL AREA AT LOS ALAMOS, *built around Ashley Pond and along Trinity Avenue*

bomb method, devised earlier at Iowa State. For plutonium, the metallurgists were as handicapped as the chemists, with only microscopic quantities available. Fortunately, many of the methods they developed for uranium proved adaptable to plutonium. Again like the chemists, the metallurgists had to devote considerable effort to devising improved recovery methods so that virtually none of the precious metal would be lost in processing it for use in a weapon.[4]

While awaiting the physical and nuclear specifications for the active materials, the laboratory's ordnance division worked on the development and proving of the mechanical components for the first experimental guns. First priority was design and fabrication of a plutonium-projectile gun. This gun type posed more problems than a uranium gun, because of Pu-239's higher propensity to predetonation, but the division's theory that a gun with sufficient muzzle velocity to avoid predetonation with Pu-239 was certain to be suitable for U-235 justified the concentration of effort.

Using standard ordnance and interior ballistics data obtained from the National Defense Research Committee (NDRC), the ordnance division had its design engineers complete the drawings for a high-velocity gun and, with subsequent approval from the Navy's Bureau of Ordnance, ordered forgings for two guns from the Naval

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[4] Ltrs, Groves to Oppenheimer, 19 Jun 44, and Oppenheimer to Groves, 27 Jun 44, Admin Files, Gen Corresp, 729.31, MDR; Ltr, Oppenheimer to Groves, 31 Aug 44, Admin Files, Gen Corresp, 400.17 (Mfg-Prod-Fab), MDR.

Gun Factory in Washington, D.C. In the meantime, while the guns were being manufactured, Captain Parsons arranged for construction of the Anchor Ranch Proving Ground, some 8 miles east of the central laboratory facilities, where, by September 1943, the division's proving ground group began testing and perfecting gun performance techniques on a limited and then increased basis.

By early 1944, gun research was advancing smoothly, despite a constant shortage of experienced personnel and difficulties in materials procurement. The division's design engineers had established the exact specifications of a low-velocity gun, to be used with U-235. Hence, because these specifications were considerably less stringent than previously anticipated for a U-235 gun, the engineers were able to reduce the original muzzle velocity requirements. This achievement made it possible for the division to place a March order with the Naval Gun Factory for three of these uranium guns, which was much earlier than expected and just days after the factory had delivered the first two plutonium prototypes to Los Alamos.[5]

Primarily because of the undeveloped state of the art, interest in implosion research for a time ranked second to that in gun assembly research. Since April 1943, physicist Seth H. Neddermeyer from the California Institute of Technology had been conducting laboratory experiments with high explosives, designed to test the feasibility of the implosion principle. Handicapped by the shortage of experienced personnel and by the general lack of enthusiasm for implosion among his colleagues, Neddermeyer's project had definitely remained a "dark horse" in the race for completion of a workable atomic device.

But all of this changed with the arrival of John von Neumann in midsummer 1943. The widely respected Hungarian-born mathematician from the Institute for Advanced Study at Princeton had been carrying out work on shock waves for the NDRC. Applying knowledge of explosives gained in his work with shaped charges, he theorized the likely effects of increasing the velocity of convergingly focused active material in the implosion bomb. His calculations convinced him that if the mechanical problems of achieving higher velocity could be solved, an implosion bomb would attain criticality using less active material of a considerably lower level of purity than hitherto believed possible. If he were correct, implosion offered a means to save precious months in developing a weapon—provided, of course, that ways could be devised to avoid predetonation and achieve symmetry in the imploding shock wave inside the bomb.

By early fall Oppenheimer, Groves, Conant, and the other project leaders were reevaluating implosion. Groves conferred with George B. Kistiakowsky, the distinguished Harvard chemist who was an expert on explosives, and with Oppenheimer and members of the laboratory's implosion study group. This led to a decision by Oppenheimer and the laboratory's governing board to expand the implosion program immediately, beginning with construction of an on-site plant for casting and trimming test components and installation of the unusual facilities required for testing implosion devices. In early November, Groves and Conant outlined the advantages of implosion to the Military Policy Committee. The following February, the committee informed the President that "there is a chance, and a fair one, if a process involving the use of a minimum amount of material proves feasible, that the first bomb can be produced in the late fall of 1944." [6]

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[5] Rpt, Parsons, sub: Summary of Ord Div, 15 Apr 44, OCG Files, Gen Corresp, MP Files, Fldr 19, Tab A, MDR; Memo, Tolman to (probably Groves), sub: Org of Ord Div at Y (Los Alamos), 1 Mar 44, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab G, MDR.

Once project leaders had approved undertaking a major developmental program for the implosion bomb, General Groves began a full and objective analysis of the laboratory's organization, personnel, and facilities for carrying it out. Consulting with von Neumann and Parsons in Washington, D.C., he arranged to have Tolman visit Los Alamos for an extended period to investigate the program. Giving special attention to the laboratory's ordnance division, Tolman prepared a detailed analysis of its organization and activities, including estimates of the additional personnel that he believed the division would require to complete the implosion program. Tolman found that the laboratory had indeed made considerable progress toward shifting priority to implosion, although Oppenheimer was not yet prepared to abandon some further efforts on the almost certain-to-work plutonium gun. [7]

By the time of Tolman's visit, the inevitable shift in emphasis from research and experimentation to engineering, fabrication, and testing was already well under way. Construction crews, under direction of Maj. Wilber A. Stevens and partially comprised of men from the Provisional Engineer Detachment, had completed or were at work on a number of essential test areas (eventually there would be more than thirty of these). They had built a facility for casting containers for explosive charges at the Anchor Ranch Proving Ground and, less than a mile to the south, were well advanced on a much larger and more elaborately equipped area—designated S (for Sawmill) Site—with a laboratory, shops, powder magazines, and even a dining hall. In addition, Major Stevens's crews had begun work on several outlying sites required especially for testing various implosion devices. Special Engineer Detatchment (SED) troops provided a considerable part of the manpower operating these test sites.

Ordnance teams from Los Alamos also assembled and tested bomb components at test sites at Wendover Field (Utah), Inyokern (California), and Alamogordo Army Air Field (New Mexico). (*See Map 2.*) For these tests, the laboratory procured normal weapon components and high explosives from a variety of government and private suppliers—the Naval Gun

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[6] Quotation from MPC Rpt, 4 Feb 44, MDR. See also Groves Diary, 20 and 29–31 Oct 43, LRG, and MPC Min, 9 Nov 43, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR.

[7] Memo, Tolman to Groves, sub: Rpt on Status of Ord Work at Y, 1 Mar 44, and attached report, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab G, MDR; Groves Diary, 21 Jan, 22 Feb, and 2–3 Mar 44, LRG.

Factory in Washington, D.C.; the Naval Ordnance Plant in Centerline, Michigan; the Naval Depot in Yorktown, Virginia; the Expert Tool and Die Company in Detroit; the Hercules Powder Company in Wilmington, Delaware; the Monsanto Chemical Company in Dayton, Ohio, to name only a few. But for special parts and materials that were unobtainable, the laboratory itself had to function as an ordnance manufacturing plant. Best illustrating this concentration of effort was the major task of converting U-235 and Pu-239 into metal bomb components.[8]

In early 1944, the laboratory intensified procurement efforts for specialized equipment for implosion testing. In April, the IBM machines needed to speed up analysis of useful data from implosion tests arrived. And in July, the Military Policy Committee approved procurement of a huge solid steel receptacle for testing the first implosion device, thus ensuring recovery of the active material in the event of a fizzle. By then, implosion development had made giant strides, but still unknown were the relative efficiency of such a design and how long it would take to build a moderately effective implosion device.[9]

Despite frequent changes in the general specifications for an atomic weapon, the laboratory's ordnance division had worked out the design of two basic bomb models by the summer of 1944. The gun-type model, the "Thin Man," was about 10 feet in length, with a varying diameter of 1.5 to 2.5 feet, and had an estimated weight (when loaded) of 5 tons. The implosion-type model, the "Fat Man," was almost as long (9 feet) but thicker, tapering down from a hemispherical nose measuring 5 feet in diameter to a tailend of about 3 feet, and had an estimated weight (when loaded) of 6 tons. Captain Parsons had the models constructed at the Applied Physics Laboratory in Silver Spring, Maryland, and tested at the Naval Proving Ground on the Potomac River at Dahlgren, Virginia. The laboratory's delivery group then conducted in-flight tests in a modified B-29, dropping dummy models of both types of bombs, at the Muroc Army Air Field near San Francisco. The ballistical characteristics of Thin Man were satisfactory, but Fat Man displayed serious instability, fortunately soon overcome by a relatively simple modification in the tail assembly.[10]

But the sense of having achieved substantial progress in weapon design and fabrication was marred by a number of uncertainties. The feasibility of implosion had yet to be demonstrated and the rate at which U-235 and Pu-239 could be produced by the Clinton and Hanford plants remained very much in question. And in July,

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[8] MDH, Bk. 8, Vol. 1, "General," pp. 5.12-5.13, 6.12, Apps. A8 (Site Map) and D16 (Site Constr Data), and Vol. 2, pp. VII.30-VII.31, XVI.12, XVI.14-XVI.15, XIX.1-XIX.5, DASA; Hewlett and Anderson, *New World*, pp. 312-17.

[9] Groves, *Now It Can Be Told*, pp. 288-89; MPC Min, 23 Jul 44, MDR. The bottle-shaped steel receptacle for the implosion device was designated "Jumbo" because of its massive size (25 by 12 feet) and weight (214 tons).

[10] MPC Rpt, 7 Aug 44, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab K, MDR. Ltr, Parsons to Groves, 24 Dec 43; Rpt, Parsons, sub: Prgm for Flight Test of Dummy Bombs from B-29 Plane, 24 Dec 43. Both in Admin Files, Gen Corresp, 600.913, MDR. Ltr, Parsons to Norman F. Ramsey (Delivery Gp, Los Alamos Lab), 17 Jul 43, Admin Files, Gen Corresp, 600.12 (Research), MDR.

Los Alamos scientists furnished disquieting new data on the plutonium that would be produced in the Hanford piles, indicating the composition of its neutron background would cause predetonation in the plutonium gun.

Project scientists had known for some time that in the process of irradiating uranium in the pile some of the Pu-239 was likely to pick up an extra neutron, forming Pu-240. When plutonium from the Clinton pilot pile became available in the spring of 1944, the radioactivity group at Los Alamos ran a series of tests that confirmed the presence of Pu-240 and indicated it would be present in far larger amounts in plutonium from the Hanford piles. Hence, the neutron background of the active material for the bombs would be several hundred times greater than was permissible. While the Pu-240 could be separated from the Pu-239 by the electromagnetic process, construction of a plant to do so would delay production of a plutonium weapon for many months.

Oppenheimer informed Conant of the 240 problem in early July. To decide how best to deal with it, Conant took immediate steps to assemble project leaders for a conference at the Metallurgical Laboratory on the seventeenth. Besides Conant, the following were in attendance: Oppenheimer, Compton, Charles A. Thomas, in his capacity as coordinator of active material purification research, Fermi, Groves, and Nichols. After some deliberation, the group decided that the predetonation threat posed by 240 made the use of plutonium in the gun-type bomb impracticable and work on this system should be suspended immediately. With this decision, even greater urgency was placed on the development of a workable implosion weapon, in which the 240, because of the higher velocities involved, would be unlikely to cause predetonation.[11]

Abandonment of the plutonium gun compelled General Groves to revise his predictions on when an atomic weapon would be ready for employment against the enemy. In a progress report to General Marshall in early August, he presented a revised timetable of weapon production: five to eleven implosion bombs in the period from March through June 1945, with an additional twenty to forty implosion bombs of the same size by the end of the year. He cautioned, however, that this schedule would not apply "if experiments yet to be conducted with an implosion type bomb do not fulfill expectations and we are required to rely on the gun type alone" and suggested that, if this delay should occur, the first bomb would not be ready until 1 August 1945, with one or two more by the year's end. In Groves's opinion, any delay virtually guaranteed that the bomb would not be used against Germany, which by the late summer of 1944 appeared likely to be defeated within a few months. And to many, even the bomb's use against Japan seemed doubtful.[12]

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[11] Groves Diary, 17–18 Jul 44, LRG; Ltrs, Oppenheimer to Conant, 11 Jul 44, and Tolman to Groves, 21 Jul 44, OSRD; Ltr, Oppenheimer to Groves, 18 Jul 44, Admin Files, Gen Corresp, 400.17 (Mfg-Prod-Fab), MDR.

[12] Quotation from MPC Rpt, 7 Aug 44, MDR. Groves continued to hold to the idea that the Germans might soon be ready to use an atomic weapon against the Allies and, therefore, that the Americans must continue to be prepared to counter this threat

Continued

Through the remaining months of 1944 and the first half of 1945, programs to perfect the uranium gun and implosion principle absorbed the major energies and resources of the reorganized laboratory. As predicted by the Los Alamos scientists, development of the gun moved ahead smoothly with few serious problems. Experiments by the laboratory's physicists proved the correctness of earlier estimates of the critical mass of the U-235 metal required for the gun and the gun group conducted successful firing tests, using a full-sized tube and substituting U-238 for U-235.

Implosion, by way of contrast, continued to be afflicted with doubts and uncertainties. Progress toward achieving sufficient symmetry in implosion was discouragingly slow. Of the various implosion bomb designs, that proposing the use of explosive "lenses" appeared most feasible.[13] A more accurate assessment was achieved with the first tests: Results were so unpromising that in December 1944 Groves and Conant concluded that U-235 should not be used in an implosion bomb but be conserved for the certain-to-work gun.[14]

As the new year opened, surprising developments dispelled the lingering air of discouragement. In February, when Groves, Tolman, and Conant visited Los Alamos, they found far more reasons for optimism. A few days before their arrival on the twenty-seventh, the gun group finally had frozen design on the U-235 weapon, indicating a usable model would be ready by July. Implosion also had made notable progress, and laboratory leaders decided, in a conference that Groves attended, to manufacture the implosion model favored by Oppenheimer. And to ensure at least one implosion bomb test with active material by 4 July, Oppenheimer also decided to use the California Institute of Technology's Project Camel facilities for construction of a second model with alternate design features. At this juncture, with data from Hanford indicating that shipments of plutonium in quantity would begin to arrive at Los Alamos in May, with experiments on accurate establishment of the critical measurements on Pu-239 in progress at the Metallurgical Laboratory, and with construction of a much larger plant for final purification of plutonium at

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with their own atomic weapon. But Hewlett and Anderson (*New World*, p. 253) note that earlier developments all pointed to Japan, not Germany, as the ultimate target for the bomb. As early as May 1943, the Military Policy Committee (see MPC Min, 5 May 43, OGG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR) concluded that the optimum target would be the Japanese fleet anchored at Truk. Then in September of that year choice of the new B-29, scheduled for employment in the Pacific Theater, over the British Lancaster seemed to imply that the bomb was to be used against Japan. See Ch. XXVI.

[13] Tubes, shaped like optical lenses and filled with high explosives, were placed in a symmetrical pattern around the active material (Pu-239). When the explosives detonated, they created an inward blast that compressed the active material until it reached a critical mass.

[14] Rpt, Cmdr A. Francis Birch (Gun Gp Ldr, Los Alamos Lab), sub: Gun-assembled Nuclear Bomb, 6 Oct 45, OCG Files, Gen Corresp, MP Files, Fldr 16, Tab E; Ltr, Oppenheimer to Groves, 30 Jun 45, and Rpt, prepared by Bristish scientists at Los Alamos, 7 May 45, OCG Files, Gen Corresp, MP Files, Fldr 17; Ltrs, Oppenheimer to Groves, 6 Oct and 14 Nov 44, Admin Files, Gen Corresp, 600.12 (Research); Ltr, Oppenheimer to Groves, 8 Dec 44, OCG Files, Gen Corresp, MP Files, Fldr 19, Tab D. All in MDR. Rpt, Conant, sub: Summary of Trip to Y, Dec 44, OSRD. Groves Diary, 19 Dec 44, LRG. Hewlett and Anderson, *New World*, pp. 317-21.

Los Alamos well under way, the Trinity test date now appeared feasible.[15]

Project Trinity: The Test of the Bomb

Project Trinity was the final step of the Los Alamos weapon program, the culmination of the laboratory's reorientation from research and experimentation to engineering, fabrication, and testing of an atomic device. Without Trinity, without the test of the bomb, the feasibility of employing the new weapon appeared to be much more questionable. "If we do not have accurate test data from Trinity," Oppenheimer and Kistiakowsky had warned, "the planning of the use of the gadget over the enemy territory will have to be done substantially blindly." As 1945 unfolded, the Trinity mission became the central focus for the scientists at Los Alamos. With the bomb test now first priority, the tempo and intensity of Trinity preparations increased dramatically.[16]

In the critical months of early 1945, making the gadget work consumed the energies of both the bomb builders and Army leaders. While the scientists worked at perfecting implosion assembly and field teams prepared the remote Trinity test site at Alamogordo, General Groves and his new deputy commander, Brig. Gen. Thomas F. Farrell, devoted much time to overseeing Trinity preparations. Because of pressures of other responsibilities, including planning for use of the bomb against Japan and for the postwar control of atomic energy, Groves managed only three hurried visits to Los Alamos during the months of full-scale preparations (April to July), but he was able to maintain day-to-day contact with bomb test developments through timely observation reports from Farrell, who made several extended tours to the Trinity site.

As Trinity preparations began, Groves had advised Colonel Tyler, the Los Alamos post commander, that he must carefully coordinate plans for development of the bomb test with the laboratory staff and with Farrell "so that every part of it fits into a time schedule." As procurement crises built up in April and May, Groves personally intervened in expediting requisition of lenses for the implosion bomb and globe-shaped container shells ("pumpkins") for imploding test devices. In May, with a special report by Farrell on means to improve the procurement situation at the New Mexico installation to guide him, the Manhattan commander con-

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[15] Rpt, Birch, sub: Gun-assembled Nuclear Bomb, 6 Oct 45, MDR; Memo, Groves to Secy War, sub: Atomic Fission Bombs, 23 Apr 45, OCG Files, MP Files, Fldr 25, Tab M, MDR; Groves Diary, 27 Feb–2 Mar 45, LRG. On the continuing program to establish more exact measurements concerning plutonium see Memos, Groves to Nichols, sub: Measurements Prgm, 3 Apr 45, and Nichols to Groves, 10 Apr 45, same sub, Admin Files, Gen Corresp, 400.12 (Experiments), MDR. On the expansion of plutonium fabrication facilities at Los Alamos see MDH, Bk. 8, Vol. 2, XVII.20–XVII.22, DASA, and Ltr, Roger Williams (TNX Div chief, Du Pont) to Groves, 16 May 45, Admin Files, Gen Corresp, 337, MDR. For the views of the British scientists at Los Alamos on the progress of bomb development in early 1945 see Admin Files, Gen Corresp, 201 (Chadwick), MDR.

[16] Quotation from Rpt, Oppenheimer and Kistiakowsky, sub: Activities at Trinity, 13 Oct 44, Admin Files, Gen Corresp, 600.12 (Los Alamos), MDR. Except as otherwise indicated, the section that follows on the Trinity test is based on MDH, Bk. 8, Vol. 2, pp. XVIII.1–XVIII.22, DASA, and Hewlett and Anderson, *New World*, pp. 376–80. For a popular account see Lamont, *Day of Trinity*, pp. 2–13 and 72–236.

Brig. Gen. Thomas A. Farrell (*right*)
with General Groves

tributed to the agreement with the University of California to hire more procurement personnel. Finally, in the weeks immediately preceding the test, Groves and Farrell devoted special attention to shipment and receipt of active materials from Hanford and Clinton.[17]

General Farrell represented the Army at Trinity's first major event on 7 May—a rehearsal shot of 100 tons of high explosives combined with a very small amount of radioactive fission materials atop a 20-foot platform. Observers, including Tolman and Oppenheimer, judged it a successful trial run for the final implosion test. It gave the various Project Trinity teams practical experience in performing their assignments under difficult field conditions, demonstrated a need for improvements in the transportation and communications facilities, helped calibrate instruments, and provided a likely indication of the amount of radioactive materials needed for the final test.[18]

In early June, "Jumbo," the huge steel container to be used in exploding the first atomic device, arrived at Trinity. General Groves had maintained a special interest in the design, procurement, and shipment of the vessel, which was moved in early April on a special railroad car from Barberton, Ohio, via a carefully planned route to a railroad siding at Pope, New Mexico. There, Trinity workers loaded it on a massive trailer pulled by two tractors for the 25-mile trip to the test site. When the vessel finally came to rest some 800 yards from the final test tower, there it remained never to be used. For by the time of Jumbo's arrival, Los Alamos scientists had decided to dispense with the container, concluding that its use would interfere with obtaining adequate data on the nature of the atomic explosion—the primary reason for conducting the Trinity test.[19]

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[17] In January 1945, after the Secretary of War had advised the Manhattan commander that he should select an officer who could replace him in the event of his illness or death, Groves chose Farrell, a Corps of Engineers officer who, in 1941, had served as his deputy in the military construction program before going overseas to the China-Burma-India Theater. See Groves, *Now It Can Be Told*, pp. 30–32; Groves Diary, 9 Jan, 1 Feb, 23 Mar, 29 Mar (source of quotation), Apr–Jun 45, passim, LRG; Memo for File, Groves, sub: Note Taken at Mtg at Y, 27 Jun 45, OCG Files, Gen Corresp, MP Files, Fldr 20, Tab F, MDR.

[18] Rpt, sub: Trinity, 14 May 45, Admin Files, Gen Corresp, 319.1 (Trinity Test Rpts–Misc), MDR; Memo, Col Stafford L. Warren (MD Med Sec chief) to Groves, sub: Analysis of Problems Presented by Test II at Muriel (Trinity), 16 May 45, OCG Files, Gen Corresp, MP Files, Fldr 4, Tab H, MDR; Groves Diary, 7 May 45, LRG.

[19] Trinity scientists, too, were much more confident of the success of implosion and certain that,

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Although 4 July had been set as the target date for the test, few scientists at Los Alamos were convinced it could be met. Precise scheduling depended upon bringing a tremendous number of factors into proper juxtaposition, including weather, procurement of key components and equipment, production and shipment of active material, preparation of many experiments, and arrangement of security and safety measures. In mid-June, Oppenheimer announced to the laboratory's group leaders that 13 July was the earliest possible date, with up to ten days later not unreasonable. He based his estimate upon information provided by the laboratory's cowpuncher committee, which had primary responsibility for coordination and scheduling of Trinity.

Following another review of developments on 30 June, this committee advanced the test date to 16 July to permit inclusion of certain additional vital experiments. Two days later, Oppenheimer indicated to Groves that the laboratory leaders finally had agreed on the seventeenth. Groves, however, objected to the later date, pointing out that the situation in Washington required an earlier date. With the end of the war in Europe, Secretary Stimson was scheduled to depart in early July for the Potsdam Conference, with sessions starting on the sixteenth. The Manhattan commander undoubtedly had conferred with Conant, Tolman, and Stimson's assistants, George L. Harrison and Harvey Bundy, all of whom favored carrying out the test on the fourteenth. Again Oppenheimer consulted with the bomb test team, which reported continued difficulties with the implosion device, wiring at Trinity, and uncertainty concerning receipt of active material. On that basis he informed Groves on 3 July that the test date of the seventeenth must stand. But final preparations advanced more rapidly than expected, and Oppenheimer called Groves on the seventh to announce that the test might take place after all on the sixteenth.[20]

In the final days before the test, the Army had the major responsibility for completing security and safety arrangements. To meet the eventuality that the people living in towns and on ranches in the immediate vicinity might have to be evacuated to avoid radioactive fallout, the Army stationed a detachment of 160 enlisted men with vehicles at Socorro (New Mexico) and other strategic points along main highways a few miles north of the site. (*See Map 6.*) To supplement this detachment and also to increase security, the Army detailed about 25 CIC (Counterintelligence Corps) members to towns and cities up to 100 miles from the Trinity site, with instructions to summon evacua-

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with the rapidly increasing production at the Hanford and Clinton Works, more active material would be available. For further details on Jumbo see MDH, Bk. 8, Vol. 2, p. XVIII.6, DASA; Groves Diary, 30 Mar 45, LRG; Memos, Groves to Alburquerque Dist Engr, sub: Trans Contract, Trinity Proj, 7 Feb 45, Capt Philip Firmin (Wash Liaison Office) to Groves, sub: Status of Jumbo and Special Trailer, 30 Mar 45, and Farrell to Groves, sub: Jumbo, 4 Jun 45, Admin Files, Gen Corresp, 400 (Equipment-Trinity), MDR; Groves, *Now It Can Be Told*, pp. 288–89.

[20] Memo, Oppenheimer to All Gp Ldrs (Los Alamos), sub: Trinity Test, 14 Jun 45, File No. 314.7 (Trinity), LASL; Ltr, Tolman to Groves, sub: Prgm for Trinity Test, 17 Apr 45, Admin Files, Gen Corresp, 400 (Equipment-Trinity), MDR; Ltr, Oppenheimer to Groves, 27 Jun 45, OSRD; Groves Diary, 2–4 and 7 Jul 45, LRG; Stimson Diary, 6 Jul 45, HLS.

tion troops if they were needed and to help circulate the Manhattan Project's cover story about an ammunition dump explosion. An officer from Groves's headquarters had already taken this story to the commander of the Alamogordo base, to be issued as soon as the test took place. Another project officer took up a station in the Associated Press office in Albuquerque to suppress any stories that might alarm the public unduly. Earlier, Groves had arranged with the Office of Censorship in Washington, D.C., to keep news of the explosion from getting into newspapers in other parts of the country. Finally, the Alamogordo commander had reluctantly acceded to the Army's request to suspend all flights during the test.[21]

Meanwhile, scientists and technicians at the Trinity site were completing preparations. On 12 July, two scientists from Los Alamos arrived in an Army sedan with the Pu-239 core for the implosion device. The next day a convoy came from the Hill with the nonnuclear components, including the high explosives. Before the test device assembly team moved the plutonium core to the tent at the base of the 100-foot steel shot tower, General Farrell signed a receipt for the active material, thus formally completing transfer of the Pu-239 from the scientists to the Army for use in the test. With all components in place except the detonating system, workers removed the tent and a hoist lifted the device to a metal shed on a platform at the top of the tower. The detonator group then completed the firing circuit and other technicians added apparatus for experiments. By five in the afternoon of the fourteenth, the device was ready for the test.[22]

The next day, a Sunday, Trinity crews carried out last-minute inspections and observers checked into the base camp, about 10 miles south of the test tower. OSRD Director Vannevar Bush and Conant arrived from Pasadena with General Groves; Army sedans brought Charles Thomas from Santa Fe and Ernest Lawrence, Sir James Chadwick, and *New York Times* science reporter William L. Laurence, as well as others, from Albuquerque. Compton had decided not to come. Tolman and General Farrell were already on hand. The large contingent from Los Alamos, aboard three buses, did not reach Trinity until shortly before three in the morning of 16 July, barely in time for the originally scheduled zero hour, 4:00 A.M. They stepped out into blustery and rainy weather with occasional flashes of lightning—not the clear skies and moderate winds the Trinity meteorologists had predicted.[23]

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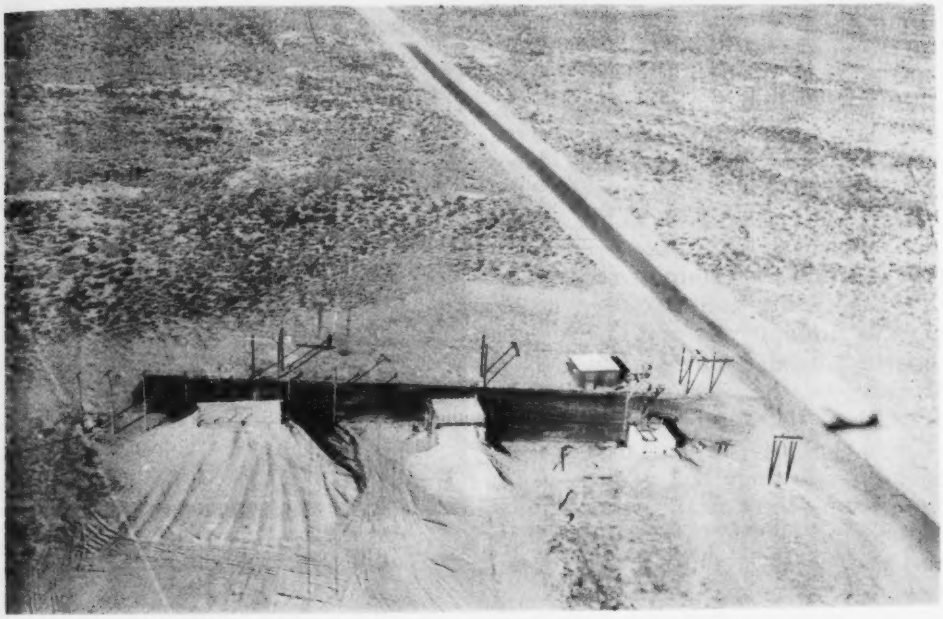
[21] Groves, *Now It Can Be Told*, pp. 299-301; Memo, 14 May 45, OCG Files, Gen Corresp, MP Files, Fldr 4, Tab A; Notes on Interim Committee Mtg, 18 May 45, OCG Files, Gen Corresp, Groves Files, Fldr 3, Tab O. See also materials and reports in Admin Files, Gen Corresp, 319.1 (Trinity Test Rpts-Misc). All in MDR.

[22] MDH, Bk. 8, Vol. 2, pp. XVIII.12-XVIII.14, DASA; Hewlett and Anderson, *New World*, p. 378; Product Receipt No. 5502, signed by Farrell and approved by Groves, 13 Jul 45, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab I, MDR. This is the receipt registering the transfer of Pu-239 from the Los Alamos Laboratory to the Army. In a note appended by Farrell on 16 July, he states that he "witnessed the expenditure of the above materials in the first nuclear explosion thus marking the birth of the age of atomics."

[23] Groves Diary, 11-14 Jul 45, LRG; Groves, *Now It Can Be Told*, pp. 290-91.



Trinity Control Dugout and Observation Post, *located six miles from the detonation point*

Oppenheimer and Groves had reviewed the weather situation at midnight and then had gone forward from the base camp some 7,000 yards to the control dugout (10,000 yards from the test tower) to wait with Farrell, physicist Kenneth Bainbridge, who was the leader of the bomb test team, and chief meteorologist Jack M. Hubbard, who with Oppenheimer had responsibility for making the final decision on whether to carry out the test as scheduled. As four o'clock approached and the rain continued, Groves and Oppenheimer weighed the risks of going ahead—the likelihood of heavier radioactive fallout at some points, electrical failures from dampened circuits, and poor visibility for the observation airplanes. They decided to delay the shot an hour and a half. The rain stopped at four and shortly before five, with wind still blowing in the right direction, they gave the go-ahead signal for the test.[24]

As the final countdown began, Groves left Oppenheimer and Farrell in the control dugout and returned to the base camp, a better point of observation and in compliance with the Manhattan chief's rule that he and Farrell must not be together in situations where there was an element of danger. At approximately the same time, the five Trinity scientists who had been guarding the test device drove away in their jeeps as bright

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[24] Memo, Groves to Secy War, sub: The Test, 18 Jul 45, HB Files, Fldr 49, MDR; Groves, *Now It Can Be Told*, pp. 291–95 and 433–40 (App. 8, which is a

Continued

lights illuminated the tower to foil any would-be saboteurs. Precisely at 5:30 A.M., an automatic firing mechanism actuated the implosion device.

Data from hundreds of instruments recorded what occurred in that desolate stretch of the Jornada del Muerto valley: the dawn of the atomic age. It began with a brilliant yellow light that suffused the remotest recesses of the Trinity site and was seen as far away as Albuquerque and Los Alamos to the north, Silver City (New Mexico) to the west, and El Paso (Texas) to the south. With the light came a sensation of heat that persisted even as a huge ball of fire—like a rising sun—took shape, then transformed quickly into a moving orange and red column. Out of this broad spectrum of colors rose a narrower column that rapidly spilled over to form a giant white mushroom cloud surrounded by a blue glow. Only as the glow began to fade did observers at the base camp feel the pressure of the shock wave, but its rumble reverberated for more than five minutes in the surrounding hills.[25]

THE ATOMIC EXPLOSION AT TRINITY, 16 JULY 1945

The effects of this explosion on eyewitnesses were as varied as the observers themselves. What General Farrell, for example, saw and heard from the control dugout was "unprecedented, magnificent, beautiful, stupendous and terrifying. . . . The whole country was lighted by a searing light with the intensity many times that of the midday sun. It was golden, purple, violet, gray and blue. It lighted every peak, crevasse and ridge of the nearby mountain range with a beauty . . . the great poets dream about. . . . Thirty seconds after, the explosion came . . . followed almost immediately by the strong, sustained, awesome roar which warned of doomsday. . . ." What General Groves recalled was that "Drs. Conant and Bush and myself were struck by an even stronger feeling that the faith of those who had been responsible for the initiation and the carrying-on of the Herculean project had been justified. I personally thought of Blondin crossing Niagara Falls on his tightrope, only to me this tightrope had lasted almost three years, and of my repeated, confident-appearing assurances that such a

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reprint of the 18 Jul 45 memorandum with some editorial changes and without inclosures); MDH, Bk. 8, Vol. 2, pp. XVIII.14–XVIII.15, DASA; Memo, Warren to Groves, sub: Safeguards for Test II at Muriel (Trinity), 27 Jun 45, OCG Files, Gen Corresp, MP Files, Fldr 4, Tab H, MDR.

[25] Hewlett and Anderson, *New World*, p. 379. See also the eyewitness and other reports on the Trinity test in Admin Files, Gen Corresp, 319.1 (Trinity Test Rpts–Misc), MDR.

thing was possible and that we would do it."[26]

But the Manhattan commander permitted himself only a fleeting moment of relaxation. Less than half an hour after the test shot he called his secretary in Washington, D.C., to inform George Harrison so that he could pass on word of the test to Stimson in Potsdam. Groves's two main concerns were the explosive strength of the implosion device and the impact of the test on project security. There were strong indications, Groves reported, that the strength of the explosion was at least "satisfactory plus" and perhaps far greater than estimated. As to the effects of the test on project security, he would take the necessary measures as soon as its impact on the public had become apparent. By late morning there was evidence that the explosion had aroused considerable excitement throughout New Mexico and in west Texas, near El Paso. Groves gave permission to the Associated Press at Albuquerque to release the previously prepared cover story with such changes as were necessary to fit the exact circumstances of the test:

> Alamogordo, N.M., July 16
>
> The commanding officer of the Alamogordo Army Air Base made the following statement today:
>
> Several inquiries have been received concerning a heavy explosion which occurred on the Alamogordo Air Base reservation this morning.
>
> A remotely located ammunition magazine containing a considerable amount of high explosives and pyrotechnics exploded.
>
> There was no loss of life or injury to anyone, and the property damage outside of the explosive magazine itself was negligible.
>
> Weather conditions affecting the content of gas shells exploded by the blast may make it desirable for the Army to evacuate temporarily a few civilians from their homes.[27]

That same afternoon, news of the momentous event reached Secretary Stimson in Potsdam:

> Operated on this morning. Diagnosis not yet complete but results seem satisfactory and already exceed expectations. Local press release necessary as interest extends great distance. Dr. Groves pleased. He returns tomorrow. I will keep you posted.[28]

A follow-up cable from Harrison confirmed the success, tentatively implied in the first message:

> Doctor has just returned most enthusiastic and confident that the little boy is as husky as his big brother. The light in his eyes discernible from here to High Hold and I could have heard his screams from here to my farm.[29]

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[26] In his 18 Jul 45 memorandum (source of quotations) for the Secretary of War in Potsdam describing the Trinity test in detail, Groves incorporated Farrell's description of the explosion. He also attached as an inclosure Ernest Lawrence's "thoughts" on the Alamogordo test. See HB Files, Fldr 49, MDR. The memorandum and inclosure are also reproduced in U.S. Department of State, *The Conference of Berlin (The Potsdam Conference), 1945*, Foreign Relations of the United States, Diplomatic Papers, 1945, 2 vols. (Washington, D.C.: Government Printing Office, 1960), 2:1361–70.

[27] The cover story released was one of several possible versions prepared in May by personnel in Groves's office. See Memo, 14 May 45, MDR. The story is also reprinted in Groves, *Now It Can Be Told*, p. 301. A transcription of Groves's telephone call to his secretary (Mrs. Jean O'Leary) on 16 Jul 45 is in Admin Files, Gen Corresp, 319.1 (Trinity Test Rpt), MDR.

[28] Msg, Harrison to Stimson, 16 Jul 45, CM-OUT-32887, OCG Files, Gen Corresp, MP Files, Fldr 5E, Tab A. Copy also in HB Files, Fldr 64. Both in MDR.

[29] Msg, Harrison to Stimson, 17 Jul 45, CM-OUT-33556, OCG Files, Gen Corresp, MP Files, Fldr 5E, Tab A. Copy also in HB Files, Fldr 64. Both in MDR.

Stimson passed on this second cable to Truman at once, explaining to the President that Groves ("Doctor") was convinced that the implosion bomb ("little boy") was as powerful as the gun-type bomb ("big brother"). Proof of its power was the fact that the light of the explosion was visible for 250 miles (the distance from Washington to Stimson's summer home at High Hold on Long Island) and its sound was audible for 50 miles (the distance from Washington to Harrison's farm near Upperville, Virginia). Stimson, Truman, Churchill, and other Allied leaders at Potsdam were quick to realize that this preliminary evidence of the enormous power of the Trinity explosion, followed soon by more detailed substantiating data from General Groves, had introduced a new factor that would profoundly affect not only their own deliberations on how to end the war with Japan but also the whole course of international relations in the postwar world.[30]

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[30] On the limited effect of the Trinity test on project security see Notes, 1st Lt Thomas R. Mountain to Mrs. O'Leary, 17 Jul 45, Admin Files, Gen Corresp, 371.2 (Scty), MDR; Stimson Diary, 16–18 Jul 45, HLS. Subsequent detailed conclusions on the effectiveness of the implosion device are given in Memo, Groves to Chief of Staff, 30 Jul 45, OCG Files, Gen Corresp, MP Files, Fldr 4, Tab C, MDR.

CHAPTER XXVI

The Atomic Bombing of Japan

The explosion of an implosion device on 16 July 1945 at Trinity provided final confirmation to America's wartime leaders that employment of an atomic weapon in the war with Japan was indeed a strategic reality. Until 1945, the Army's supersecret atomic weapon program had not been a factor in strategic planning for carrying on the war, either in Europe or in the Pacific.[1] The successful Allied operations against Germany in the summer of 1944 portended that country's imminent collapse and obviated the need for an atomic weapon to end the conflict in Europe. Because of these developments, Manhattan Project leaders thus considered using the bomb in the war in the Pacific and accelerated preliminary planning with the Army Air Forces (AAF) for a possible atomic bombing mission against Japan.

Preparations for an Atomic Bombing Mission

Preparations for the tactical employment of an atomic weapon against Japan began in late March 1944, when General Groves first met with General Henry H. Arnold, the AAF commanding general.[2] The Manhattan commander briefed Arnold, who already had some knowledge of the atomic program, on the current status of bomb development, estimating the probable time when bombs would be ready for use in combat. He then reviewed the latest technical data from Los Alamos on the likely size, weight, and configuration of an atomic bomb, indicating that the dimensions of the gun type were reasonably well established but those for the implosion type were still very much in question.

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[1] Strategic planning for employment of the atomic bomb always was limited to the relatively few military and civilian leaders who knew of its existence. Most Army planners remained totally unaware of the atomic weapon program. In the Operations Division only three senior officers—General Malin Craig, Lt. Gen. John E. Hull, and Brig. Gen. George A. Lincoln—learned about the bomb before it was dropped on Japan. See Ray S. Cline, *Washington Command Post: The Operations Division*, U.S. Army in World War II (Washington, D.C.: Government Printing Office, 1951), p. 347.

[2] Except as otherwise indicated, this account of the long-range preparations for employment of the atomic bomb in combat is based on Ms, "History of the 509th Composite Group, 17 December 1944 to 15 August 1945," 31 Aug 45, SHRC; Cert of Audit MDE 228-46, W-47 Spec Ord Det, 27 Sep 45, Fiscal and Audit Files, Certs of Audit (Sup), MDR; Historical Notes on Svc of Col Elmer E. Kirkpatrick, Jr., With Manhattan Proj, 1944-47, Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; MDH, Bk. 8, Vol. 2, "Technical," pp. XIX.1-XIX.13, DASA; Wesley Frank Craven and James Lea Cate, eds., *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*, The Army Air Forces in World War II, Vol. 5 (Chicago: University of Chicago Press, 1953), pp. 704-09; Groves, *Now It Can Be Told*, pp. 253-62 and 277-87; Hewlett and Anderson, *New World*, pp. 252-54, 313, 317-18, 321, 334; William L. Laurence, *Dawn Over Zero: The Story of the Atomic Bomb*, 2d ed. enl. (Westport, Conn.: Greenwood Press, 1977), pp. 196-206.

The two leaders next took up the question of what type of airplane would be required to transport atomic bombs. The Manhattan commander noted that Oppenheimer, on the basis of investigations carried out at Los Alamos and Muroc Army Air Field, had concluded that a modified B–29 probably had the requisite weight-carrying capacity and range. Should the B–29, which had gone into production in September 1943, prove not feasible, Groves suggested the British Lancaster would have to be considered. This displeased Arnold, who stated emphatically that an American-made airplane should carry the bombs, and he promised to make a special effort to have a B–29 available for that purpose.[3]

With this assurance that the AAF would provide the necessary airplanes, the two leaders reached tentative agreement on a broad division of responsibilities in making the preparations for that atomic bombing mission. The AAF would organize and train the requisite tactical bomb unit, which, for reasons of security, must be as self-sustaining as possible and exercise full control over delivery of bombs on the targets selected. Manhattan would receive from the AAF whatever assistance it needed in ballistic testing of bombs and air transportation of materials and equipment. To facilitate close coordination between the two organizations, Groves would continue to have as frequent access to Arnold as he deemed necessary, and Maj. John A. Derry of Groves's staff and Maj. Gen. Oliver P. Echols, an AAF officer already serving as a consultant with Manhattan, would provide day-to-day liaison. Echols subsequently designated an alternate, Col. Roscoe C. Wilson, who since the latter part of 1943 had been providing AAF liaison with the Los Alamos delivery group in its work on B–29 modification and testing.[4]

In the ensuing months, General Groves personally assisted the AAF in developing an overall and concrete tactical plan. As soon as the anticipated schedule of fission bomb production was available, Groves supplied Colonel Wilson with the crucial data. Drawing upon estimates he had recently prepared for the Military Policy Committee's August progress report to the Secretary of War, Chief of Staff, and Vice President, the Manhattan commander indicated to Wilson that an implosion-type bomb might be ready as early as January 1945 and a gun-type bomb by June of that year. Although these dates were slightly in advance of those in the progress report, they illustrate a precautionary maneuver on Groves's part "to avoid any possible unnecessary delay in the use of the bomb. . . ."[5] Pending completion of the fission bombs, Groves assured Wilson that, for testing purposes, Manhattan would supply the AAF with several hundred high-explosive bombs having ballistic characteristics similar to the implosion-type model.[6]

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[3] Groves Diary, 21 Mar 44, LRG; H. H. Arnold, *Global Mission* (New York: Harper and Brothers, 1949), p. 491.

[4] On the earlier liaison arrangements with the AAF see MPC Min, 9 Nov 43, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; MDH, Bk 8, Vol. 2, pp. VII.35–VII.39, DASA. The frequent consultations between Manhattan and AAF personnel during the fall and winter of 1944 are recorded in Groves Diary, Sep–Dec 44, passim, LRG.

[5] Groves, *Now It Can Be Told*, p. 256, n. 2.

On the basis of this data, Wilson drafted a general plan outlining the support the AAF would provide in preparation for the atomic bombing mission. The AAF committed itself to supply the personnel and equipment for a heavy bomb squadron, with attached special units as required, and to make available an air base in the southwestern United States for its training. In addition, it agreed to modify and complete delivery of fourteen B–29's to the squadron by 1 January 1945; to continue flight testing of implosion-type bombs, with related training under direction of Manhattan and AAF specialists; and to assist Manhattan personnel in testing equipment and assembling ballistic data. Finally, the AAF would participate in a field inspection of a suitable site for an overseas operating base on the Mariana Islands in the Central Pacific.

To command the bomb combat unit, subsequently designated the 509th Composite Group and formally activated on 17 December 1944, General Arnold selected Col. Paul W. Tibbets, Jr. Tibbets had an outstanding record in flying heavy bombers in Europe and North Africa and had gained a special knowledge of the B–29 as a test pilot. Because of the great importance and secrecy of the 509th's mission, Arnold gave the 509th commander virtual *carte blanche* to select the best-qualified personnel available.

In September 1944, Colonel Tibbets began to assemble the elements of the 509th at Wendover Field (*see Map 2*), an isolated air base in western Utah with adequate security and facilities and well located for air travel to Los Alamos and the Salton Sea Naval Air Station.[7] The 509th commander devoted the next several months to organizing his new command, consulting frequently with Groves, Captain Parsons of the Los Alamos ordnance group, and other Manhattan representatives. Following the security guidelines set forth in Colonel Wilson's plan, Tibbets formed the various elements of the 509th with the objective of making it as self-sufficient as possible. Thus, he included in the group not only a normal B–29 unit, the 393d Bombardment Squadron (VH), but also a number of supporting elements, including the 390th Air Service Group (consisting of the 603d Air Engineering and 1027th Materiel Squadrons), the 320th Troop Carrier Squadron, and the 1395th Military Police Company (Aviation). Subsequently, for special technical requirements, the 509th acquired the 1st Ordnance Squadron, Special (Aviation), and the 1st Technical Detachment, War Department Miscellaneous Group, a catchall unit comprised of both civilian and military scientists and techni-

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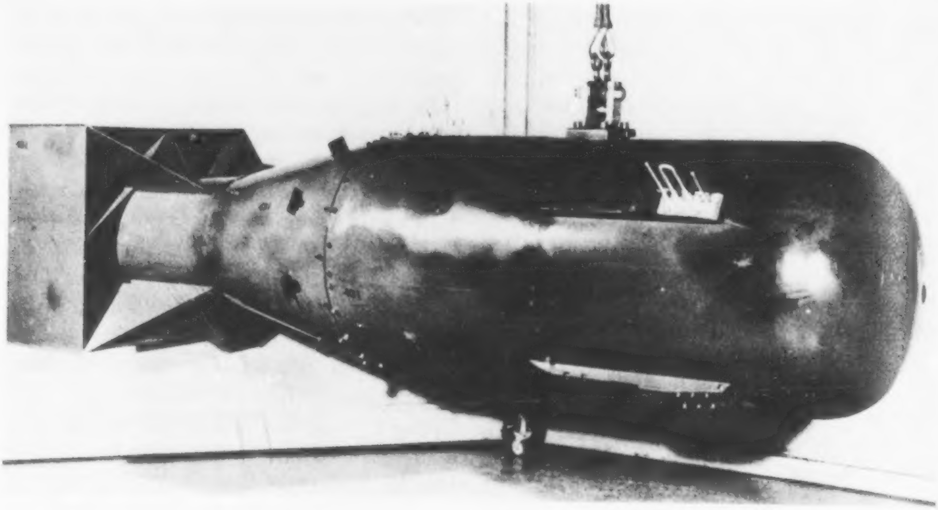
[6] See MPC Rpt, 7 Aug 44, Incl to Memo, Groves (for MPC) to Chief of Staff, same date, OCG Files, MP Files, Fldr 25, Tab K, MDR; Groves Diary, 31 Jul and 17, 21, 29 Aug 44, LRG.

[7] Los Alamos personnel, given the task of constructing bombing tables, acquired the necessary data from field measurements taken at the Salton Sea Naval Air Station, where an approach over water simulated the near sea-level conditions that would be encountered over Japan.



LITTLE BOY, *the uranium bomb dropped on Hiroshima*

cians—many from the Manhattan Project but including Army, Navy, and AAF personnel.[8]

At the beginning of September, with the external shape and aircraft requirements of the three basic bomb models—one of the U-235 gun type (now designated Little Boy instead of Thin Man) and two of the Pu-239 implosion type (Fat Man)—now frozen, the AAF started training the bomb drop squadron and, with assistance from Los Alamos technicians, completed necessary modifications on the B-29. While awaiting delivery of the first planes, scheduled under Colonel Wilson's plan to be on the thirtieth of the month, the squadron underwent training that emphasized ground and air techniques for handling atomic bombs.

In October, only days past the scheduled delivery date, the 393d received the first modified B-29's out of a production lot of fifteen (one more than originally requested). Without delay, a continuing series of essential test drops commenced at Wendover. Over the next few months, these tests furnished critical information on ballistics, electrical fusing, flight performance of electrical detonators, operation of aircraft release mechanisms, vibration, and temperatures, as well as provided bomb assembly experience. But, perhaps more importantly, they revealed certain weaknesses in the original modifications and defective performance in the flying capabilities of the big bombers.

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[8] For further details on organization and composition of the 509th see Ms, "Hist 509th Comp Gp," pp. 1-2 and 8-11, SHRC, and the unit's own postwar publication, *509th Pictorial Album: Written and Published by and for the Members of the 509th Composite Group, Tinian, 1945*, ed. Capt Jerome J. Ossip (Chicago: Rogers Printing Co., 1946). By the summer of 1945, the 509th had substantially exceeded the authorized personnel of 225 officers and 1,542 men.

FAT MAN, *the implosion bomb dropped on Nagasaki*

Because B-29's were in very short supply, the AAF's lower echelons displayed some reluctance to satisfy the Manhattan request for replacement of the inadequate planes. In December, shortly after the 393d Squadron was detailed to Batista Field, Cuba, for two months of special navigational training, Groves decided to appeal directly to General Arnold about the B-29 problem. Without hesitation, the AAF chief responded emphatically that the 509th Composite Group would get as many new planes as it required. "In view of the vast national effort that had gone into the Manhattan Project," as Groves later recalled Arnold's words, "no slip-up on the part of the Air Force was going to be responsible for a failure." [9] After the 393d returned to Wendover, the fliers continued to gain experience during tests with dummy bombs of various types. Finally, in the spring of 1945, the second lot of fifteen greatly improved versions of the B-29 reached the air base, and training and ballistic tests proceeded at a more intensive pace.

The Overseas Operating Base

With training of the 509th Composite Group and the Los Alamos program for testing bomb models well under way, project leaders turned their attention to establishing a base of operations for the 509th in the Pacific Theater. At the end of December 1944, Manhattan and AAF officials, including Groves and Arnold, met to discuss plans for moving the 509th overseas. The AAF recommended that leaders of the Twentieth Air Force in the Marianas—at the time the only feasible location for the 509th base—be informed of the atomic bomb mission. With permission from General Marshall, Groves accepted the AAF's offer to have Brig. Gen. Lauris Norstad, its assistant chief of staff for plans who would be visiting Pacific bases in January 1945, brief Lt. Gen. Millard F. Harmon, deputy commander of the Twentieth Air Force, and two of his staff officers. (Groves had to repeat the briefing again for Lt. Gen. Barney McK. Giles, who in May became Twentieth Air Force deputy commander after Harmon and the two staff officers disappeared in a flight from Guam to Washington, D.C.).[10]

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[9] Groves, *Now It Can Be Told*, p. 257.

The meeting reemphasized the need for also informing the Navy commanders in the Pacific of the atomic bomb mission, as Navy support in the immediate area of operations would be indispensable. Furthermore, Admiral Chester W. Nimitz, Commander in Chief, Pacific Ocean Areas (CINCPOA), had learned of the imminent arrival of the 509th in his theater and was asking questions concerning its mission. In February, Groves arranged with Rear Adm. William R. Purnell of the Military Policy Committee to have Comdr. Frederick L. Ashworth, Parsons' operations officer and military alternate in charge of field operations at Wendover, visit Nimitz's headquarters on Guam. Ashworth briefed Nimitz, who in turn informed two staff members of the 509th mission.[11]

Groves also had instructed Commander Ashworth to inspect carefully both Guam and Tinian as possible sites for the 509th base operations. General Norstad had recommended Guam, citing its excellent deepwater harbor and maintenance facilities. But Guam was 125 miles farther from Japan than Tinian—a critical factor considering the heavy load the B-29 would be carrying. Ashworth also found that Guam had overtaxed port facilities and a shortage of construction personnel to build an additional airfield. In contrast, airfield and port facilities under construction on Tinian would be more than adequate for the atomic bomb mission and would be ready for use by the time the 509th arrived in June. Furthermore, although the Army had jurisdiction over Tinian, the Navy's 6th Naval Construction Brigade was available there to build the special installations that would be needed by the mission.[12]

With the information he had collected on Guam and Tinian, Commander Ashworth reported to Groves on 22 February. The following day Groves wrote to Norstad, indicating his choice of Tinian as the more suitable site (*Map 7*). Norstad concurred, and on 24 February Groves briefed the Military Policy Committee. By end of the month, Navy Seabees were at work on the base facilities.[13]

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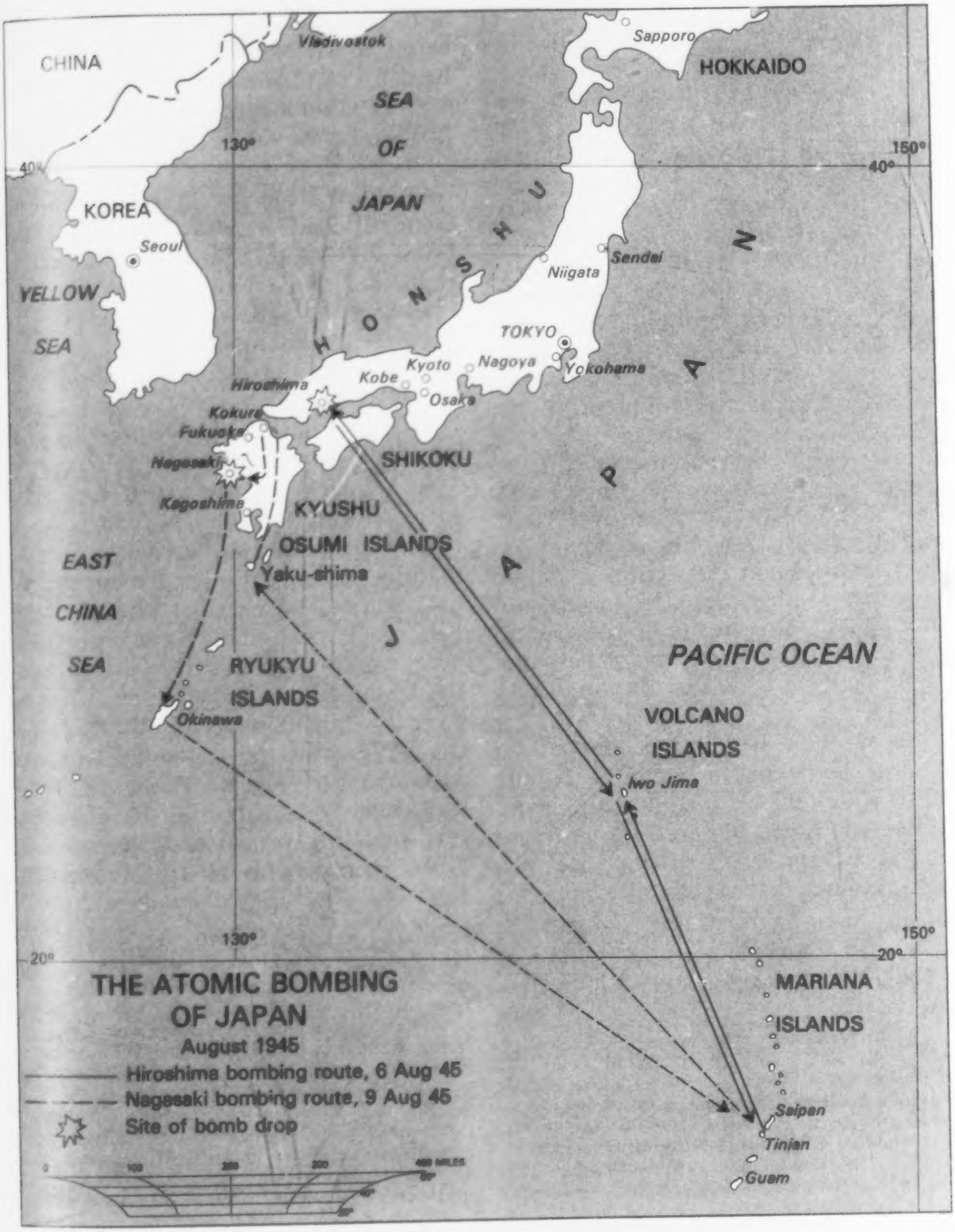
[10] MPC Min, 29 Dec 44, Exhibit H (prepared by Groves), MDR; Groves, *Now It Can Be Told*, pp. 278–79; Craven and Cate, *The Pacific*, pp. 530–31.

[11] Ltr, Groves to Chief of Staff, 30 Dec 44, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; Groves, *Now It Can Be Told*, p. 277.

[12] Memo, Ashworth to Groves, sub: Base of Opns of 509th Comp Gp, 24 Feb 45, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; Craven and Cate, *The Pacific*, pp. 516–17 and 518–19.

[13] Groves Diary, 22–24 Feb 45, LRG; MPC Min, 24 Feb 45, with Ashworth's 24 February memorandum attached as Exhibit A, MDR; Memo, Groves to Norstad, sub: Decisions Concerning Movement of 509th Comp Gp, 23 Feb 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab C, MDR; Craven and Cate, *The Pacific*, p. 706; Groves, *Now It Can Be Told*, p. 278.



THE ATOMIC BOMBING OF JAPAN

August 1945

Hiroshima bombing route, 6 Aug 45
Nagasaki bombing route, 9 Aug 45
Site of bomb drop
0
100
200
300
400 MILES
CHINA
Vladivostok
SEA OF JAPAN
Sapporo
HOKKAIDO
KOREA
Seoul
YELLOW SEA
HONSHU
Niigata
Sendai
TOKYO
Yokohama
Nagoya
Kyoto
Kobe
Osaka
Hiroshima
Kokura
Fukuoka
Nagasaki
Kagoshima
SHIKOKU
KYUSHU
OSUMI ISLANDS
Yaku-shima
EAST CHINA SEA
RYUKYU ISLANDS
Okinawa
JAPAN
PACIFIC OCEAN
VOLCANO ISLANDS
Iwo Jima
MARIANA ISLANDS
Saipan
Tinian
Guam
130°
150°
40°
20°

MAP 7

At the end of March, General Groves sent the District's deputy engineer, Col. Elmer E. Kirkpatrick, Jr., a long-time associate of the Manhattan commander on Army construction projects, to the Marianas as his personal representative with the mission of expediting delivery of the bomb components to Tinian and making sure that all essential construction work there was completed on schedule. Groves had brought Kirkpatrick to the project the previous September for the specific purpose of preparing him to monitor development of the overseas operational base. Thus, in the guise of a special assistant to Groves, he had spent considerable time at Los Alamos, Wendover Field, and Kirtland Field (near Albuquerque), assisting in inspection of bomb prototypes, observing the training of the 509th Composite Group, and helping to plan shipment of essential equipment and bomb components to Tinian.[14]

As soon as Kirkpatrick arrived on Guam, he went to Admiral Nimitz with a letter of introduction from Chief of Naval Operations Admiral Ernest J. King that explained his mission. Nimitz then assigned a member of his own staff, Capt. Thomas B. Hill, as Kirkpatrick's contact at CINCPOA headquarters. Kirkpatrick also delivered a similar letter from General Arnold to Maj. Gen. Curtis LeMay, commanding general of the XXI Bomber Command. To maintain the secrecy of his mission, Kirkpatrick was identified simply as a special representative from the War Department General Staff to the Twentieth Air Force and its XXI Bomber Command, reporting to General LeMay. He was carried as an assistant operations officer of the bomber command and quartered with the 313th Bombardment Wing, located at the same field on Tinian that would be used by the 509th Composite Group.[15]

Kirkpatrick devoted April and May to expediting facilities construction. A typical problem was a delay in unloading ships at Tinian harbor. Kirkpatrick notified Groves, who went to Admiral Purnell. The Navy representative on the Military Policy Committee obtained an order from Admiral King to Nimitz that all material for the 509th must be unloaded as soon as it reached Tinian. Another problem arose in constructing facilities on Iwo Jima for transferring an atomic bomb from one B–29 to another, in the event a bomber en route to Japan should have to make an emergency landing there. Kirkpatrick had arranged to have these facilities completed by 1 July, but an inspection by a project officer there as of that date revealed that virtually nothing had been done. Kirkpatrick informed Captain Hill, and prompt action was taken.[16]

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[14] Historical Notes . . . , Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; List of Duties . . . of Liaison Off to 509th Comp Gp, Incl to Memo, Maj John A. Derry (Groves's Asst for Proj Opns) to Groves, sub: Discussion of 5 Mar With Norstad, 10 Mar 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab C, MDR; Groves, *Now It Can Be Told*, p. 279. Colonel Kirkpatrick first worked with Groves in the Construction Division of the Quartermaster Corps. He came to the Corps of Engineers when the Construction Division was transferred to the Engineers in December 1944.

[15] Historical Notes . . . , Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; Memo, Groves (to Nimitz), 8 Mar 45, sub: Preparation and Movement of Personnel and Equipment to Tinian, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab C, MDR. Groves states in a note at the bottom of page 1 of this memorandum that he had intended to show it in person to Nimitz, who was in Washington attending strategy meetings on the war in the Pacific, but he was unsuccessful in securing an appointment. Consequently, at Groves's direction, Colonel Kirkpatrick memorized the contents of the memorandum before leaving on his trip to the Marianas and subsequently passed on the information to Nimitz at a meeting on Guam in early April. See also Craven and Cate, *The Pacific*, pp. 706–07. The Air Force historians mistakenly identify Kirkpatrick as a "Twentieth Air Force engineer."

In early May, Kirkpatrick came back to the United States for conferences with Groves and with personnel working on design and delivery of the bomb. He visited Captain Parsons at Los Alamos and other project officials there and at Wendover Field and the Inyokern test site. When Kirkpatrick returned to Tinian toward the end of the month, he found the first elements of the 509th arriving there. The group brought with it a number of C-54 transport planes, which were soon operating as a continuous shuttle service to the United States mainland, greatly facilitating movement of personnel and urgently needed equipment. By mid-July, all elements of the group had reached Tinian, including the 1st Technical Detachment comprised chiefly of civilian specialists from Los Alamos, some of whom had been brought temporarily into military service. Commanded by Parsons, the detachment furnished and tested weapon components for the 509th, supervised assembly of bombs, and checked out completed units, carefully inspecting them in bomb bays before planes took off. Frequent communication with Los Alamos threatened project security, so Groves dispatched Lt. Col. Peter de Silva, chief security officer at Los Alamos, to Tinian to establish effective security measures for the detachment, and John H. Manley, a Los Alamos physicist, to Washington, D.C., to serve as point of transmission for all project messages to Tinian.[17]

COL. ELMER E. KIRKPATRICK, JR.

Meanwhile, the 509th's combat crews were undergoing intensive flight training. This involved practicing navigation missions to Iwo Jima and making bomb runs to nearby islands still in enemy hands, using high-explosive projectiles with Fat Man's pumpkin shape. At the end of training, which lasted three weeks, the crews in late July began a series of combat strikes over Japan to gain familiarity with target areas and mission tactics and also to accustom the Japanese to the appearance of small formations of B–29's flying at a great height. Using the pumpkin-shaped bombs, the 509th achieved excellent results against enemy towns, most of which had been hit by previous B–29 strikes. These towns—Koriyama, Nagaoka, Toyama, Kobe, Yokkaichi, Ube, Wakayama, Maizuru, Fukushima, and Niihama—were in the general vicinity of those communities selected earlier as targets for atomic bombing.[18]

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[16] Historical Notes . . . . Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; Groves, *Now It Can Told*, pp. 280–81.

[17] Historical Notes . . . . Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; Memo, Kirkpatrick to Groves, 26 May 45, Admin Files, Gen Corresp, 201 (Gen), MDR; Memo, de Silva to Lt Col John Lansdale, Jr. (Groves's Spec Asst for Scty), 28 Jun 45, Admin Files, Gen Corresp, 371.2 (Scty), MDR; Groves Diary, 10 May and 31 Jul 45, LRG; MDH, Bk. 8, Vol. 2, pp. XIX.5–XIX.8, DASA; Groves, *Now It Can Be Told*, pp. 282–83.

The Bombing Targets

In the late spring and early summer of 1945, Manhattan and AAF representatives met in Washington and Los Alamos for the purpose of choosing targets for the 509th's atomic bombing mission. Normally the selection of specific bombing targets was a responsibility of the highest echelons in a theater of war. But in April, after briefing President Truman on the atomic program, General Marshall decided that the nature of Manhattan's security requirements and its inherently unique technical problems made it imperative for project leaders to have a major voice in the choice of targets, subject to final approval by himself and the Secretary of War. Hence, instead of assigning the task to the War Department General Staff's Operations Division, the Army Chief of Staff turned over this responsibility to General Groves.[19]

Although the Manhattan commander had not anticipated Marshall's decision, he moved immediately to carry out his new responsibility. After conferring with General Arnold, he and General Norstad selected a target committee. The committee included two members of Groves's staff (General Farrell, who served as *de facto* chairman when Groves was not present, and Major Derry), an AAF officer (Col. William P. Fisher), and five technical experts (John von Neumann, Robert R. Wilson, and William G. Penney, a member of the British team at Los Alamos, all from the Manhattan Project, and Joyce C. Stearns and David M. Dennison from the AAF.[20]

At the opening meeting of the target committee on 27 April, Groves briefed its members, first emphasizing the need for the highest degree of secrecy in its deliberations and then laying down some general guidelines for selection of targets. He suggested that they choose four targets and indicated that General Marshall had pointed out that ports on the west coast of Japan, vital to that country's communications with the Asiatic mainland, should not be overlooked. General Norstad then told the committee that the Twentieth Air Force would provide it with whatever support it needed, including related information, operational analyses, maps, and targets data.[21]

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[18] Craven and Cate, *The Pacific*, pp. 708–09; Ms. "Hist 509th Comp Gp," pp. 50–55 and 58–61, SHRC; Memo, de Silva to Lansdale, 28 Jun 45, Admin Files, Gen Corresp, 371.2 (Scty), MDR.

[19] Groves Diary, 23 Apr 45, LRG; Groves, *Now It Can Be Told*, pp. 266–67.

[20] Groves Diary, 23 Apr 45, LRG; Groves, *Now It Can Be Told*, pp. 266–68; Hewlett and Anderson, *New World*, p. 365.

The second committee meeting took place on 10 May in Los Alamos, where committee members had an opportunity to hear from the scientists and technicians who had worked on the bomb. At the third meeting in Washington on 28 May, Colonel Tibbets and Commander Ashworth, who had returned from Tinian for consultation, and scientific adviser Richard C. Tolman provided further data. The committee carefully considered various criteria: the maximum range for the loaded B–29 aircraft; the need for visual bombing; likely weather conditions; and expected damage. The last criterion weighed heavily on the committee, for it pointed up the necessity to select targets where the bomb would produce the maximum damage and hence have the profoundest impact upon enemy morale. Project scientists had indicated that the bomb would most likely achieve the desired results if it were dropped on densely built-up areas of significant value to the Japanese war effort. They also had emphasized that the targets should not have been bombed previously, so the effects might be assessed more accurately.[22]

Before concluding its 28 May meeting, the committee recommended four targets to General Groves, who promptly approved all of them. The choices were Kokura Arsenal, one of Japan's largest munitions plants, covering an area of 8 million square feet; Hiroshima, a major military embarkation port and convoy assembly point with a local army headquarters, railway yards, storage depots, and some heavy industrial plants; Niigata, an important seaport with significant industrial and commercial facilities, including an aluminum reduction plant, a large ironworks, an oil refinery, and a tanker terminal; and Kyoto, with a concentrated 3-square-mile industrial area and a population of about one million people. As soon as he received the committee's list, Groves prepared a plan of operations for General Marshall based upon the identified target choices.[23]

On 30 May, before delivering the plan of operations to General Marshall, Groves visited the Secretary of War on other business. The Secretary used the opportunity to query the Manhattan commander on the target choices. As soon as Groves mentioned Kyoto, Stimson expressed strong objection, noting that the city had been the ancient capital of Japan and was a place of great religious and cultural significance to the Japanese. Groves pointed out that Kyoto's large population and military and industrial importance made it an exceptionally suitable target, but the Secretary of War held fast to his views.

The target committee, nevertheless, did not find an immediate substitute for Kyoto. General Arnold included it in his instructions in early June to the Twentieth Air Force to withhold conventional bombing of the four selected targets. So did Groves in late June, when he requested General Marshall to inform General Douglas MacArthur and Admiral Nimitz to refrain from attacking the target cities, but probably with the intention of making certain that Kyoto was not subjected to ordinary bombing. The Manhattan commander endeavored to change Stimson's mind on a number of occasions, but the Secretary remained adamant. Finally, on 21 July, Stimson, who was in Germany attending the Potsdam Conference, received a cable signed by special assistant George L. Harrison but certainly inspired by Groves: "All your local military advisors engaged in preparation definitely favor your pet city and would like to feel free to use it as first choice if those on the ride select it out of 4 possible spots in the light of local conditions at the time." [24] After conferring with President Truman, Stimson replied: "Give name of place or alternate places, always excluding the particular place against which I have decided. My decision has been confirmed by highest authority." [25] When the atomic bomb directive was issued to the United States Army Strategic Air Forces (USASTAF) on 25 July, Nagasaki had replaced Kyoto on the target list.[26]

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[21] Groves Diary, 27 Apr 45, LRG; Notes on Target Committee Mtg, 27 Apr 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab D, MDR.

[22] Notes on Target Committee Mtg, 27 Apr and 28 May 45, MDR; Ms, Manhattan Engineer District, "The Atomic Bombings of Hiroshima and Nagasaki," June 1946, pp. 5–8, LC; Groves, *Now It Can Be Told*, p. 270."

[23] Groves, *Now It Can Be Told*, pp. 272–73; Ltr, Norstad through Dep Cdr, Twentieth Air Force, to CG XXI Bomber Cmd, sub: 509th Comp Gp Spec Functions, 29 May 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab C, MDR. This letter appears to contain the substance of Groves's plan of operations, including reference to three of the four committee target choices (Kokura Arsenal is missing).

The Decision To Use the Bomb

Meanwhile, the question of military employment of the bomb against Japan came up for consideration by the Interim Committee, a temporary body appointed by Stimson in May 1945 at the urging of project leaders and with the approval of the President. The committee's function was to advise and report on atomic energy matters. Membership was comprised of the Secretary of War, as chairman; George Harrison, as alternate chairman; former War Mobilization Director James F. Byrnes, representing the President; Vannevar Bush; James B. Conant; MIT President Karl T. Compton; Assistant Secretary of State for Economic Affairs William L. Clayton; and Under Secretary of the Navy Ralph A. Bard. At its first meeting on the ninth, Stimson outlined the parameters of the committee's broad authority—from advising on wartime controls and publicity releases to making recommendations on postwar policies concerning research, development, and control of atomic energy (including legislation). He did not mention that the committee would also advise on the military use of the bomb, but the interrelationship between this aspect of atomic energy and war and postwar controls made

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[24] Msg, Harrison to Stimson, 21 Jul 45, CM-OUT-35987, OCG Files, Gen Corresp, MP Files, Fldr 5E, Tab A, MDR.

[25] Msg, Stimson to Harrison, 23 Jul 45, CM-IN-23195, OCG Files, Gen Corresp, MP Files, Fldr 5E, Tab C, MDR.

[26] Ltr Directive, Gen Thomas T. Handy (Act Chief of Staff) to Gen Carl A. Spaatz (CG USASTAF), 25 Jul 45; Memo, Groves to Norstad, 30 May 45; Memo, Groves to Chief of Staff, 30 Jun 45. All in OCG Files, Gen Corresp, MP Files, Fldr 5, Tab B, MDR. Stimson Dairy, 30 May, 6 Jun, 22 and 24 Jul 45, HLS. In the entry of 30 May, Stimson mentions the conference on S-1 but says nothing about targets. Groves Diary, 30 May 45, LRG. Stimson and Bundy, *On Active Service*, p. 625. Groves, *Now It Can Be Told*, pp. 273-76. Nagasaki, the city substituted for Kyoto on the bomb target list, was a major military port—one of Japan's largest shipbuilding and repair centers—and a producer of naval ordnance.

REPUBLICS
SEA OF OKHOTSK
MANCHURIA
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GENERAL GROVES CHECKING LOCATION OF BOMBING TARGETS

its involvement in that decision almost inevitable.[27]

At its next meeting on the fourteenth, the Interim Committee established a scientific panel, comprised of Oppenheimer, Fermi, Arthur Compton, and Lawrence. This group presented its views on the technical and political aspects of atomic energy at the fourth meeting of the committee on the thirty-first, which Generals Groves and Marshall attended. While recognizing that use of the bomb was essentially a military matter, the panel members nevertheless offered their opinions concerning the way it should be employed and the likely effects it would have on the targets selected. Oppenheimer closed the panel's briefing by emphasizing that the atomic bomb would have a different impact from any previous weapon because "the visual effect . . . would be tremendous, it would be accompanied by a brilliant luminescence which would rise to a height of 10,000 to

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[27] See Ch. XXVII for a detailed discussion of the Interim Committee's activities in the preparation of press releases and public statements, and in planning for postwar controls and legislation. On the committee's organization and first meeting see Stimson Diary, 25 Apr and 2-3 and 8-9 May 45, HLS; Memo, Bundy to Secy War, 2 Mar 45, OCG Files, Gen Corresp, MP Files, Fldr 9, Tab A, MDR; Groves Diary, 9 May 45, LRG. See also in MDR, HB Files, the following: Notes on Interim Committee Mtgs, 9 and 17 May 45, Fldr 100; Interim Committee Log, 9 May 45, Fldr 98; Ltrs, Secy War to Conant, 4 May 45, and Conant to Secy War, 5 May 45, Fldr 69; Memo, Harrison to Secy War, sub: Interim Committee on S-1, 1 May 45, Fldr 69.

20,000 feet, [and] the neutron effect . . . would be dangerous to life for a radius of at least two-thirds of a mile."

Taking a moment to reflect on the discussion of targets and effects, Secretary Stimson proffered the conclusion that the atomic bomb should be used against Japan with no advance warning and, while not restricting the target to a civilian area, should be employed in such a way as "to make a profound psychological impression on as many of the inhabitants as possible." Both committee and panel members generally agreed, and the discussion continued. Conant suggested that the "most desirable target would be a vital war plant employing a large number of workers and closely surrounded by workers' houses," and Stimson indicated that was the type of target he also visualized. When Oppenheimer proposed that several simultaneous strikes would be feasible, Groves strongly objected. Such tactics, he stated, would eliminate the possibility of "gaining additional knowledge of the new weapon at each successive bombing . . . , would require a rush job on the part of those assembling the bombs and might, therefore, be ineffective, [and] the effect would not be sufficiently distinct from . . . regular Air Force bombing. . . ." [28]

Panel members left the 31 May meeting with the Secretary's instructions that they should prepare suggestions on postwar organization, research, and development for the Interim Committee. Arthur Compton was very much aware that there was great concern and substantial difference of opinion among Metallurgical Laboratory scientists on how to deal with postwar problems and programs. And in the interest of maintaining the morale of his scientific staff, he requested suggestions from them on the future of atomic energy, which he might then pass on to the scientific panel.

Among the various reports Compton received in the following two weeks was one prepared by a group of scientists under the leadership of James Franck, an outstanding German-refugee physicist who had come to the Metallurgical Laboratory from the staff of the University of Chicago. Centering on the political and social ramifications of an atomic bombing, the Franck report favored eventual international control of atomic energy as the only safe solution. Using the bomb against Japan without adequate warning, the report cautioned, would arouse great animosity against the United States and isolate her morally among the nations of the world, making establishment of international controls much more difficult. As an alternative, the report advocated a demonstration of the bomb in an uninhabited area, pointing out that this action would not prevent later military use of the bomb against Japan, if this were necessary. [29]

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[28] Quotations in this and the preceding paragraph from Notes on Interim Committee Mtg, 31 May 45, MDR. See also Memo, 1st Lt R. Gordon Arneson (Interim Committee Secy) to Harrison, 6 Jun 45, HB Files, Fldr 100, MDR; Hewlett and Anderson, *New World*, pp. 356–59.

[29] The Franck report, signed by Franck and six of his fellow scientists at the Metallurgical Laboratory (David J. Hughes, James J. Nickson, Eugene Rabinowitch, Glenn Seaborg, Joyce Stearns, and Leo Szilard), was published under the title "Before Hiroshima" in *Bulletin of the Atomic Scientists*, 1 May 46. See also Compton, *Atomic Quest*, pp. 233–36; Hewlett and Anderson, *New World*, p. 366.

Some members of the Franck group did not feel that they could depend upon the scientific panel to bring their views to the attention of government leaders, so Franck himself carried the report to the capital. There, Arthur Compton saw to its delivery on 12 June to George Harrison's office at the War Department. Harrison, acting in his capacity as alternate chairman of the Interim Committee, decided that the Franck report should be turned over to the scientific panel for possible inclusion in the latter's own report on the use of the bomb.

Both the Franck report and the scientific panel's report were discussed at the meeting of the Interim Committee on the twenty-first. In contrast to the Franck report's recommendation that the bomb be used first in a technical demonstration made public to other countries, the panel's report—which acknowledged the differing views of project scientists on how the bomb should be employed—concluded that it could "propose no technical demonstration likely to bring an end to the war . . . [and] see no acceptable alternative to direct military use." [30] After considering the panel's views, the Interim Committee reaffirmed its earlier position "that the weapon be used against Japan at the earliest opportunity . . . without warning, and . . . on a dual target, namely a military installation or war plant surrounded by or adjacent to homes or other buildings most susceptible to damage." [31]

On 21 July, Stimson received not only Groves's detailed report on the successful test at Trinity, delivered by special courier, but also cables from Harrison indicating that atomic bombs would be ready sooner than expected. He promptly passed the word to American and British leaders at Potsdam, including President Truman, Prime Minister Churchill, Secretary of State Byrnes (as of 3 July), General Marshall, and Lord Cherwell, all of whom were elated by the news. On the twenty-fourth, Stimson showed the President the tentative plan of operations, which Groves had prepared and which he (Stimson) had received the day before from Harrison. This plan called for the first atomic bombing mission any time after 1 August, subject to completion of preparations and suitable weather. Truman accepted the plan without reservation, for, Stimson recalled, "that was just what he wanted. . . ." [32]

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[30] Rpt, Scientific Panel, sub: Recommendations on the Immediate Use of Nuclear Wpns, 16 Jun 45. This report, one of three prepared by the panel on various aspects of the control and employment of atomic energy, is attached to Ltr, Oppenheimer (for Scientific Panel) to Secy War, Attn: Harrison, 16 Jun 45, OCG Files, Gen Corresp, Groves Files, Fldr 3, Tab T, MDR.

[31] Notes on Interim Committee Mtg, 21 Jun 45, MDR; Ltr, Compton to Stimson, 12 Jun 45, and Incl (unsigned copy of Franck report), OCG Files, Gen Corresp, Groves Files, Fldr 3, Tab T, MDR; Interim Committee Log, 12 and 15–16 Jun 45, HB Files, Fldr 98, MDR; Compton, *Atomic Quest*, pp. 233–36 and 239–41; Hewlett and Anderson, *New World*, pp. 365–69.

[32] Stimson Diary, 16–19 and 21–24 Jul 45 (quotation from 24 July), HLS. Memo, Groves to Secy War, sub: The Test, 18 Jul 45, HB Files, Fldr 49, MDR. Msgs, Harrison to Secy War, 21 Jul 45, CM-OUT-35988, Tab B; Secy War to Harrison, 23 Jul 45, CM-IN-23487, Tab C; Harrison to Secy War, 23 Jul 45, CM-OUT-36792 and CM-OUT-37350, Tab A, OCG Files, Gen Corresp, MP Files, Fldr 5E, MDR (copies in HB Files, Fldr 64, MDR). Groves, *Now It Can Be Told*, pp. 309–10. Truman later recalled that he had reached a decision in favor of using the atomic bomb on the basis of recommen-

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On 25 July, General Marshall submitted to Stimson the draft of the USASTAF directive to proceed with the atomic bombing of Japan, and the Secretary—with assurance that all the Allied leaders favored going ahead with employment of the bomb—approved it. The directive carefully spelled out the procedures that were to govern the atomic bombing mission:

> 1. The 509 Composite Group, 20th Air Force will deliver its first special bomb as soon as weather will permit visual bombing after about 3 August 1945 on one of the targets: Hiroshima, Kokura, Niigata and Nagasaki. To carry military and civilian scientific personnel from the War Department to observe and record the effects of the explosion of the bomb, additional aircaft will accompany the airplane carrying the bomb. The observing planes will stay several miles distant from the point of impact of the bomb.
>
> 2. Additional bombs will be delivered on the above targets as soon as made ready by the project staff. Further instructions will be issued concerning targets other than those listed above.
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> 3. Dissemination of any or all information concerning the use of the weapon against Japan is reserved to the Secretary of War and the President of the United States. No communiques on the subject or release of information will be issued by Commanders in the field without specific prior authority. Any news stories will be sent to the War Department for special clearance.
>
> 4. The foregoing directive is issued to you by direction and with the approval of the Secretary of War and of the Chief of Staff, USA. It is desired that you personally deliver one copy of this directive to General MacArthur and one copy to Admiral Nimitz for their information.[33]

Dropping the Bomb

Manhattan played an important supporting role in the AAF's execution of the 25 July directive. At the top level, General Groves continued to retain a voice in the general direction of the mission, through his access to General Arnold's staff in Washington, through his two representatives on Tinian (Colonel Kirkpatrick and, as of 31 July, General Farrell) and through Admiral Purnell, whom Admiral King had assigned to coordinate the bombing with Navy commanders in the Pacific Theater.[34]

General Farrell arrived in the Central Pacific area with specific instructions from Groves: to coordinate ongoing preparations for dropping the first atomic bomb on Japan. Farrell first stopped on Guam, where he conferred with General LeMay, who would shortly become USASTAF

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dations of his military advisers and after Churchill had told him at Potsdam that he was convinced it should be employed "if it might aid to end the war" (see Harry S. Truman, *Memoirs*, 2 vols. [Garden City, N.Y.: Doubleday and Co., 1955–56], 1:419). Truman subsequently informed Air Force historians that he actually gave the order for dropping the bombs on Hiroshima and Nagasaki in the mid-Atlantic while returning to the United States from Potsdam on board the cruiser USS *Augusta* (2–7 Aug 45). See Ltr, Truman to Cate, 12 Jan 53, reproduced in Craven and Cate, *The Pacific*, between pp. 712–13. For a further discussion on the decision to use the bomb see Louis Morton, "The Decision To Use the Atomic Bomb," in *Command Decisions*, ed. Kent Roberts Greenfield (Washington, D.C.: Government Printing Office, 1960), pp. 493–518.

[33] Ltr Directive, Handy to Spaatz, 25 Jul 45, MDR. A copy of the original directive is reproduced in Craven and Cate, *The Pacific*, following page 696. See also Groves, *Now It Can Be Told*, pp. 308–09.

[34] Groves, *Now It Can Be Told*, p. 311; Memo, Groves to Chief of Staff, sub: Plan of Opns–Atomic Fission Bomb, 24 Jul 45, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab P, MDR; Groves Diary, 24–26 and 31 Jul 45, LRG; Rpt, Farrell, sub: Overseas Opns–Atomic Bomb, ca. 15 Sep 45, Admin Files, Rpts Pertaining to the Effects of the Atomic Bomb, Farrell, MDR; Testimony of Farrell in *Atomic Energy Hearings on S. Res. 179*, p. 502.

ENOLA GAY
82

COL. PAUL W. TIBBETS, JR. (*center*), WITH GROUND CREW AT TINIAN

chief of staff, and with Admiral Nimitz. Moving on to Tinian, Farrell visited Admiral Purnell and Captain Parsons.[35]

Farrell spent considerable time with Parsons, who talked at length about the intensive activities of the 1st Technical Detachment on Tinian during the month of July. The detachment, with assistance from other elements of the 509th and the Navy, had installed the technical facilities required for assembly and testing of bomb components, especially with Little Boy, and had carefully checked out the emergency reloading facilities at Iwo Jima. Parsons also informed Farrell about the function of his newly formed project technical committee, namely, to assist him in planning and coordinating with AAF elements the complex final tests and assembly of both the gun-type and implosion weapons.[36]

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[35] Rpt, Farrell, sub: Overseas Opns–Atomic Bomb, ca. 15 Sep 45, MDR; Historical Notes . . . , Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD.

[36] Memo, E. J. Doll (Delivery Gp, Tinian) to Parsons, sub: Summary of Spec Mtg (24 Jul 45) of Wpns Committee, 27 Jul 45; Memo, Norman F. Ramsey (Delivery Gp, Tinian) to Parsons, sub: Summary of Spec Mtg (27 Jul 45) of Proj Tech Committee, 28 Jul 45, and Incl (Table 1, Schedule of Events); ibid., sub: Summary of Mtg (30 Jul 45) of Proj Tech Committee, 6 Aug 45. All in OCG Files,

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Component parts and active material for both types of atomic bombs reached the detachment on Tinian only shortly before they were actually used in bombing missions. Those for Little Boy arrived first. Most of its components and the U-235 had left Los Alamos in mid-July in custody of Maj. Robert R. Furman, a special projects officer from Groves's Washington headquarters, and Capt. James F. Nolan, chief medical officer at the New Mexico installation. They traveled by automobile from Santa Fe to Albuquerque, by airplane to Hamilton Field near San Francisco, thence to Hunters Point to board the cruiser *Indianapolis*. Crossing the Pacific in record time, they reached Tinian on 26 July.[37] Two Los Alamos security officers brought the remaining components and the rest of the active material for Little Boy aboard two C-54 cargo aircraft, the first arriving at Tinian on the twenty-eighth and the second on the following day.[38]

The 509th technical teams quickly assembled the Little Boy unit, and Parsons requested permission from Groves to drop it as early as 1 August. But weather conditions for the first four days of the month were unsuitable. During this period, the technical teams and bombing crews worked on an around-the-clock basis, perfecting plans for delivering Little Boy and carrying out tests on Fat Man rehearsal units. At the same time, components for the Fat Man arrived at Tinian aboard two B-29's that Groves had held at Albuquerque for that purpose and plutonium active material came in aboard a C-54.[39]

Finally, on the morning of the fifth, AAF meteorologists indicated that visual bombing should be possible over the target cities on the following day, and General LeMay directed that the Littly Boy mission would take place on the sixth. Technical teams loaded the bomb in the *Enola Gay* B-29 aircraft and completed the final testing of the unit. A few days earlier bomb technicians had worked out a method for reducing the danger of a premature explosion by delaying final arming until the aircraft was airborne. Captain Parsons, who was to go on the flight as the bomb commander, had responsibility for performing this function.

The final briefing took place at midnight, and the weather planes departed for the target area. Hiroshima was the primary target, Kokura second, and then Nagasaki (*see Map 7*). In the meantime, a C-54 had carried Colonel Kirkpatrick and a crew from the technical group to Iwo Jima to stand by to transfer the bomb to a spare B-29 if the strike aircraft had to land there.[40]

Tinian Files, Env B, 200 (Kirkpatrick), MDR. See also MDH, Bk. 8, Vol. 2, pp. XIX.7-XIX.8, DASA.

[37] A Japanese submarine sank the ill-fated *Indianapolis* four days later en route to the Philippines. See Richard F. Newcomb, *Abandon Ship! Death of the USS Indianapolis* (New York: Holt, Rinehart and Winston, 1958).

[38] MDH, Bk. 8, Vol. 2, pp. XIX.8-XIX.9, DASA; Groves, *Now It Can Be Told*, pp. 305-08; Craven and Cate, *The Pacific*, pp. 714-15; Testimonies of Groves and physicist Philip Morrison (Los Alamos Lab) in *Atomic Energy Hearings on S. Res. 179*, pp. 39-40 and 234-35.

[39] MDH, Bk. 8, Vol. 2, pp. XIX.8 and XIX.10, DASA; Rpt, Farrell, sub: Overseas Opns-Atomic Bomb, ca. 15 Sep 45, MDR; Historical Notes [illegible], Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; Groves Diary, 4 Aug 45, LRG; Memo, Groves to Chief of Staff, 6 Aug 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab B, MDR.

[40] MDH, Bk. 8, Vol. 2, XIX.8-XIX.9, DASA; Memo, Groves to Chief of Staff, 6 Aug 45, MDR;

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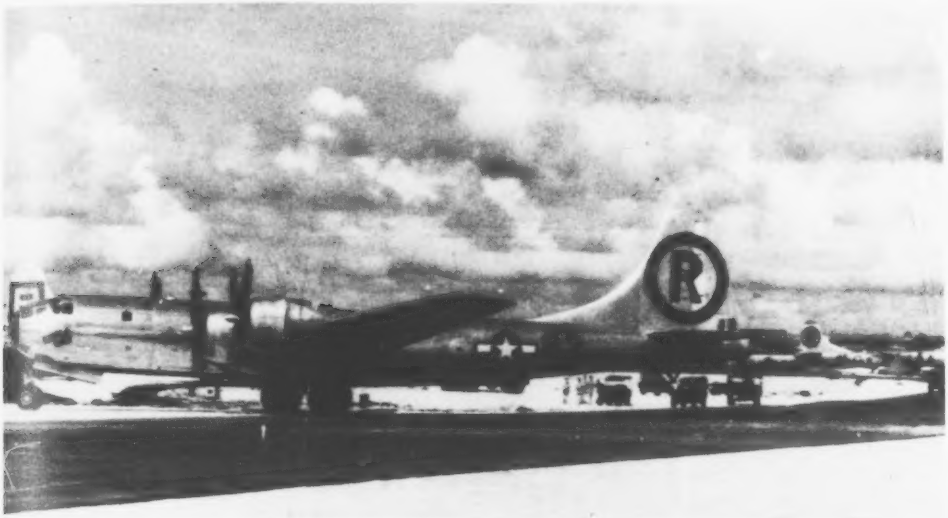

ENOLA GAY AT TINIAN

At 0245 (Tinian time) on 6 August, with Little Boy in her bomb bay and Colonel Tibbets at the controls, the *Enola Gay* lifted off the Tinian runway, followed at two-minute intervals by two observation planes carrying recording instruments and scientific observers, most of them from the Manhattan Project. Tibbets' instructions were to choose the target on the basis of reports from the weather planes—Hiroshima was preferred because it was the one target that had no American prisoner-of-war camp—and, if all were closed in, to return with the bomb.[41]

Captain Parsons kept the log of the flight that described in terse phrases the progress of the historic mission:

0300 Started final loading of gun.
0315 Finished loading.
0605 Headed for the Empire from Iwo.
0730 Red plugs in [these plugs armed the bomb so it would detonate if released].
0741 Started climb. Weather report received that weather over primary and tertiary targets was good but not secondary target.
0838 Leveled off at 32,700 feet.
0847 All Archies [electronic fuses] tested to be OK.
0904 Course west.

Historical Notes . . . , Incl to Ltr, Kirkpatrick to OCEHD, 30 Sep 68, OCEHD; Craven and Cate, *The Pacific*, p. 176

[41] At the end of July, General Spaatz had cabled General Groves, calling attention to the reported location of prisoner-of-war camps near some of the target areas selected for atomic bombing and requesting advice on how this should affect his orders to the 509th Composite Group. Groves consulted with General Handy, the Acting Chief of Staff, and they agreed that Spaatz should be told to disregard the purported presence of prisoner-of-war camps in issuing his orders. Handy, however, believed that Stimson should be informed of this policy. Accordingly, Groves showed the Secretary of War both the cable from Spaatz and his reply to the USASTAF commander. Stimson, by taking no action, in effect approved the policy. See Groves, *Now It Can Be Told*, pp. 312-13.

0909 Target [Hiroshima] in sight.
0915½ Dropped bomb [Originally scheduled time was 0915]. Flash followed by two slaps on plane. Huge cloud.
1000 Still in sight of cloud which must be over 40,000 feet high.
1003 Fighter reported.
1041 Lost sight of cloud 363 miles from Hiroshima with the aircraft being 26,000 feet high.[42]

About fifteen minutes after the bomb was dropped, Parsons radioed back to Farrell on Tinian in a special code: "Results clear cut, successful in all respects. Visible results greater than Trinity. Conditions normal in airplane following delivery. Proceeding to Tinian." Farrell promptly relayed this first report to Groves, waiting anxiously in Washington, but because of unexplained communications delays, it did not reach him until 11:30 P.M. (Washington time), 5 August, more than four hours after the dropping of the bomb. At 4:30 the next morning Groves received a detailed cable from Farrell, dispatched after return of the *Enola Gay* to Tinian. This cable became the basis of Groves's report to General Marshall at the Pentagon and, by telephone, to Stimson at home. Farrell's cable also provided most of the confirmation Groves needed to clear for release to the press the President's statement, prepared earlier by the Interim Committee. The one point on which the cable lacked sufficient information was the amount of damage inflicted on Hiroshima. To avoid any chance of overstatement that might reduce the announcement's effect on the Japanese, Groves obtained from General LeMay on Guam assurance that the bomb appeared to have caused enormous destruction. Then at 11:00 A.M. the President's press secretary (Truman was still en route home from Potsdam) released the statement to the waiting newsmen at the White House, giving the American people their first news of the atomic bombing of Japan and of the wartime project that made it possible.[43]

Meanwhile on Tinian, the 509th's weapon assembly teams prepared for the first Fat Man mission, scheduled for 11 August. Rapid progress with assembly of the implosion unit led Parsons to propose to Tibbets on the seventh that the mission be moved up to the tenth. But forecasts indicated that a period of bad weather was due to begin on the tenth and last for five days. Would it be possible, Tibbets asked Parsons, to have the bomb ready by the ninth? Parsons expressed uncertainty as to whether the bomb could be safely readied in so short a time, but agreed to try. Working without letup, the technical teams succeeded in assembling, loading, and checking the unit by the evening of the eighth. Kokura was the primary target and Nagasaki, the secondary

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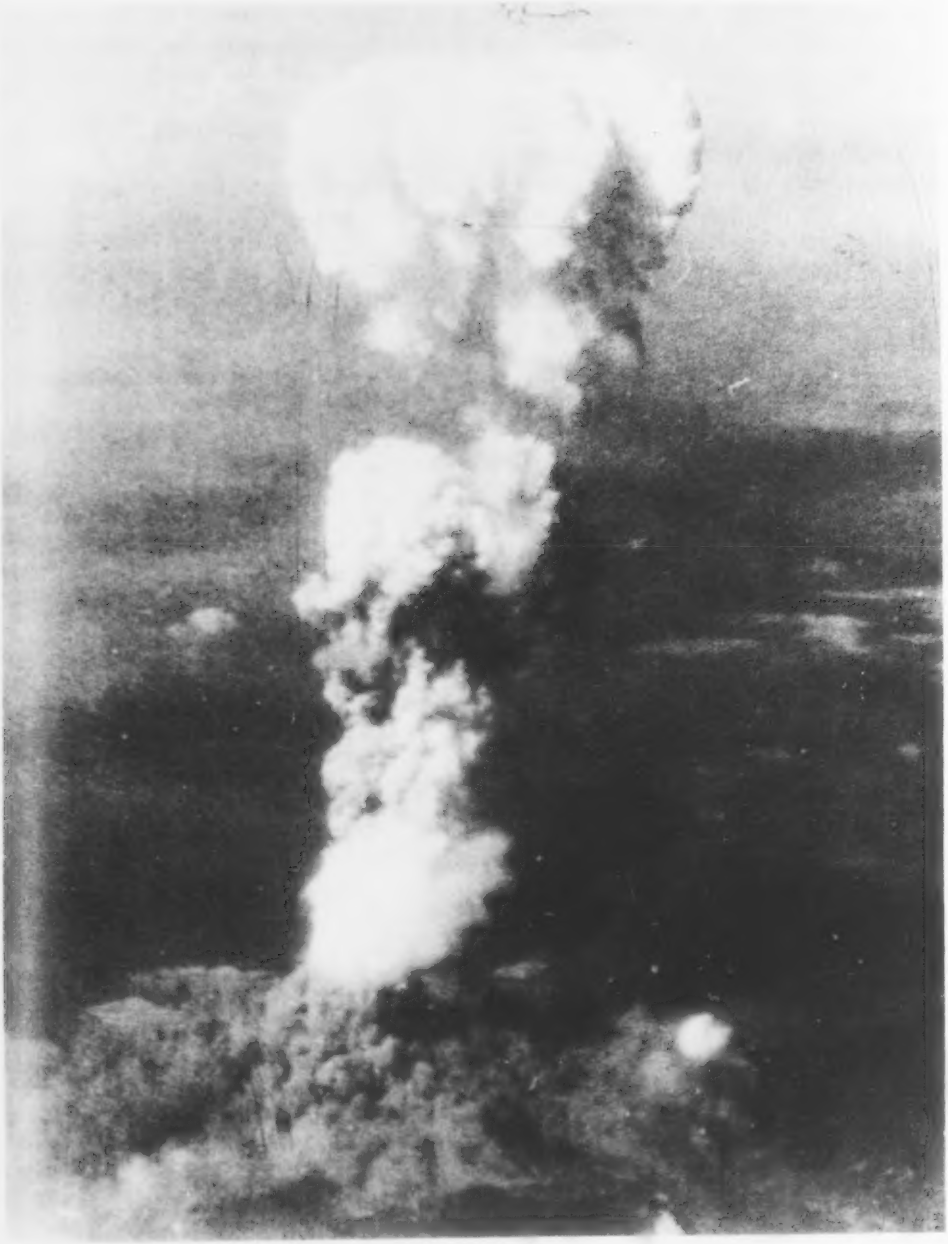
[42] The log is reproduced in MDH, Bk. 8, Vol. 2, XIX.9–XIX.10, DASA.

[43] Quote from Rpt, Farrell, sub: Overseas Opns-Atomic Bomb, ca. 15 Sep 45, MDR. Groves, *Now It Can Be Told*, pp. 320–31. Farrell's message to Groves is reprinted on page 323. Groves's report to Marshall on the bombing of Hiroshima is the memorandum of 6 Aug 45, filed in MDR, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab B. The presidential statement is in *Harry S. Truman, 1945*, Public Papers of the Presidents of the United States (Washington, D.C.: Government Printing Office, 1961), pp. 197–200.



Mushroom Cloud Over Hiroshima

objective. Niigata was excluded as being too far away from Tinian.[44]

Shortly before dawn on 9 August, the B–29 strike plane *Bock's Car*, with Maj. Charles W. Sweeney as pilot and Commander Ashworth as the bomb commander, prepared to take off with two observer aircraft. Sweeney's original flight plan designated the same route to Japan via the Volcano Islands followed by the Hiroshima mission, again to provide for an emergency stop if needed on Iwo Jima. Again Colonel Kirkpatrick awaited with a bomb-loading team and a spare B–29. Just before lift-off, the *Bock's Car* crew discovered that the fuel pump for the plane's reserve gasoline tank in the bomb bay was not working properly. Normally such a mechanical problem would have aborted the mission. But faced with a prediction of worsening weather and knowing the importance to the Allied surrender negotiations with Japan of having a second atomic bomb attack closely follow the first, Farrell decided to risk going ahead with the mission.[45]

The defective fuel pump was only one of a number of difficulties that were to make the second atomic bombing mission as eventful as the first was routine. Taking off at about 0347,[46] the strike plane and accompanying aircraft did not attempt to fly in formation because of the bad weather between Tinian and Iwo Jima. To get around this weather and to save fuel, they headed separately for a rendezvous point at Yaku-shima off the coast of Japan. Commander Ashworth succinctly recorded in the log of the flight the succeeding series of events that threatened the mission with failure and very nearly with disaster:

0900 Arrived rendezvous point at Yakashima [*sic*] and circled awaiting accompanying aircraft.

0920 One B–29 sighted and joined in formation.

0950 Departed from Yakashima [*sic*] proceeding to primary target Kokura having failed to rendezvous with second B–29. The weather reports received by radio indicated good weather at Kokura (3/10 low clouds, no intermediate or high clouds, and forecast of improving conditions). The weather reports for Nagasaki were good but increasing cloudiness was forecast. For this reason the primary target was selected.

1044 Arrived initial point and started bombing runs on target. Target was obscured by heavy ground haze and smoke. Two additional runs were made hoping that the target might be picked up after closer observations. However, at no time was the aiming point seen. It was then decided to proceed to Nagasaki after approximately 45 minutes spent in target area.

At this point, Ashworth and Sweeney determined they had only enough gasoline to make a single bombing run over Nagasaki, if they were to reach the closest alternate landing field on Okinawa. More than one run would require ditching *Bock's Car*:

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[44] MDH, Bk. 8, Vol. 2, XIX.10–XIX.11, DASA; Rpt, Farrell, sub: Overseas Opns–Atomic Bomb, ca. 15 Sep 45, MDR; Craven and Cate, *The Pacific*, pp. 718–19.

[45] Groves, *Now It Can Be Told*, p. 344.

[46] The 0347 takeoff time is recorded by Ashworth in the log of the mission. Other sources vary as to the precise moment of lift-off. Farrell states in his 15 September report that the time was 0348; Craven and Cate, the Air Force historians, fix it at 0349 (*The Pacific*, p. 719); and *New York Times* science reporter William Laurence, who was riding as an observer in one of the instrument planes, recorded it as 0350 (*Dawn Over Zero*, p. 231). Ashworth's log is reprinted in MDH, Bk. 8, Vol. 2, pp. XIX.11–XIX.12, DASA.

1150 Arrived in Nagasaki target area. Approach to target was entirely by radar. At 1150 the bomb was dropped after a 20 second visual bombing run. The bomb functioned normally in all respects.
1205 Departed for Okinawa after having circled smoke column. . . .
1351 Landed at Yontan Field, Okinawa.
1706 Departed Okinawa for Tinian.
2245 Landed at Tinian.

Ashworth radioed first word of the bombing of Nagasaki to Farrell on Tinian while *Bock's Car* was en route to Okinawa, indicating some uncertainty as to the results, although the visible effects appeared to him about equivalent to those at Hiroshima. On Okinawa, Ashworth consulted with all the crews and observers and concluded that the implosion bomb had been satisfactorily placed over the target. They reported that the flash was brighter, the shock waves greater, and the cloud was larger and moved up faster than at Hiroshima. But photographs taken four hours after the strike showed little because of the cloud, smoke, and dust cover. Only days later would additional photographs reveal that the entire industrial part of Nagasaki and a considerable part of the residential area had been destroyed.[47]

The Surrender of Japan

As soon as he received word of the successful bombing of Nagasaki, General Groves felt certain Japan's capitulation would follow. He went at once to see General Marshall to discuss future operations against Japan. They agreed that, in view of Stimson's policy of using the bomb only to end the war, shipment of materials for a third bomb should be delayed until 13 August. When by that date the Japanese still had not surrendered, neither the Secretary of War nor the Chief of Staff was available to Groves for consultation because of the continuing negotiations for an armistice. Groves then went to General Thomas T. Handy, Acting Chief of Staff, and informed him that he would order the continued holding of all fissionable materials in the United States, requesting Handy to pass this information on to Stimson and Marshall at the earliest opportunity. Meanwhile, project personnel at Los Alamos and on Tinian also continued in full readiness to prepare and deliver additional atomic bombs.[48]

The march of events vindicated Groves in his decision. On 14 August, President Truman received a message from the Japanese government that constituted full and satisfactory acceptance of the Allied terms of surrender, as set forth in the Potsdam Declaration. The judicious employment of atomic bombs in tandem with a series of warnings to the Japanese government of more to come if it did not yield had comprised the strategy in the final successful maneuverings for the surrender. To the average observer in the West in mid-1945, the Japanese decision to comply with Allied terms appeared to be the direct result of the atomic bombing of Hiroshima and Nagasaki, the Soviet Union's declaration of war against Japan on 9 August, and the Allied promise not to alter the legal position of Emperor Hirohito. Yet, with the advantage of hindsight and a detailed knowledge of developments within Japan in the weeks preceding the surrender, a leading historian on the subject makes clear that the "decision—in embryo—had long been taking shape." [49]

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[47] For other accounts of the bombing of Nagasaki see Craven and Cate, *The Pacific*, p. 719–21; Laurence, *Dawn Over Zero*, pp. 228–43; Groves, *Now It Can Be Told*, pp. 344–46.

[48] Groves, *Now It Can Be Told*, pp. 352–53.

By the spring of 1945, the Japanese armed forces had brought the Empire to the brink of disaster. Broad public support for the military had begun to disintegrate as the people of Japan came to realize that the very survival of their country was threatened. When Premier Kantaro Suzuki replaced General Hideki Tojo in April, the government initiated a definite campaign to seek an end of the war on terms acceptable to the ruling elite. But this campaign, begun in June with efforts to open peace negotiations through the Soviet Union, was of little avail as long as the Japanese militarists dominated the government and the Allies were unwilling to guarantee the future status of the Emperor. Only the shock impact of the atomic bombings of Hiroshima and Nagasaki, combined with the Soviet entry into the war, created "that unusual atmosphere in which the theretofore static factors of the Emperor could be made active in such an extraordinary way as to work what was virtually a political miracle. . . . It was the nation's good fortune that, in spite of the existence of a hard-headed and strongwilled corps of fanatics, the men responsible for the movement to terminate the war were finally able, under the circumstances of 1945, to give the fullest possible effect to the depth of appeal in the voice of the man who is the supreme symbol in Japanese life and thought." [50]

The surrender of Japan on 14 August completed the mission of Manhattan's Project Alberta group, assigned to the 1st Technical Detachment, on Tinian. Most technical personnel of the Alberta group originally planned to return to the United States on the twentieth, leaving only a small team under General Farrell that was to go to Japan to investigate the results of the bombing. But when delays developed in arranging surrender procedures, General Groves requested that essential project personnel remain on Tinian pending successful completion of the occupation of Japan. Project Alberta scientists and technicians finally left Tinian on 7 September. Colonel Kirkpatrick and Commander Ashworth stayed behind to make final disposition of project property, taking special care to return to Los Alamos under guard or to dump in the sea any items likely to reveal information about the bomb. Some project property went with the investigating teams assembled under General Farrell, to be used in surveying the effects of atomic bombing on Hiroshima and Nagasaki.[51]

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[49] Robert J. C. Butow, *Japan's Decision To Surrender* (Stanford, Calif.: Stanford University Press, 1954), p. 231.

[50] Ibid., pp. 231 and 233.

[51] For the official account of the closing out of Project Alberta see MDH, Bk. 8, Vol. 2, p. XIX.13, DASA.

Survey of the Bombing Effects

The swift surrender of Japan opened the way for American scientific teams to survey, on the ground, the specific effects of the atomic bombing of Hiroshima and Nagasaki. Not only were scientists, medical personnel, and professional military men greatly interested in learning the results of the first employment of atomic weapons in warfare, but also the commanders of the occupation troops that were scheduled shortly to move into the two bombed cities desired a check of the possible hazards with which they might have to cope. Although Manhattan scientists were virtually sure that detonation of the atomic bombs a considerable distance above the ground had eliminated the likelihood of any lingering large-scale radioactivity in the two cities, lacking previous experience they could not be certain without actual inspection of the affected areas.[52]

Thus, when General Groves heard from General Marshall on 10 August that the Japanese had started surrender negotiations, he took steps to organize Manhattan Project teams to carry out atomic investigations in Hiroshima and Nagasaki, as well as elsewhere in the home islands. On the eleventh, the Manhattan commander directed District Engineer Nichols to select qualified project personnel and procure the special equipment the teams would need to perform their mission. He also sent instructions to General Farrell that he was to be in command of the Manhattan survey teams going into Japan. Farrell began to assemble medical, scientific, and intelligence personnel already on Tinian to participate in the investigations. On the twelfth, three days before General MacArthur's appointment as Supreme Commander for the Allied Powers (SCAP), Japan, General Marshall informed him of the purpose of the survey groups, clearing the way for their early entry into Japan.

Meanwhile, Colonel Nichols, with assistance primarily from the medical staff of the District, hurriedly brought together fifteen officers and twelve enlisted men from the Clinton Laboratories, Metallurgical Laboratory, Los Alamos, the Monsanto Chemical Company, and the University of Rochester. Comprised chiefly of medical scientists and individuals trained in taking radiation measurements, this group rendezvoused on the twelfth at Hamilton Field in California and departed for Tinian on the following day.

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[52] This account of the effects of atomic bombs on Hiroshima and Nagasaki is based primarily upon the following sources: MDH, Bk. 1, Vol. 4, "Auxiliary Activities," Ch. 6 (Investigation of the After Effects of the Bombing in Japan), DASA; Ms, MED, "The Atomic Bombings of Hiroshima and Nagasaki," June 1946, LC; MED, "Photographs of the Atomic Bombings of Hiroshima and Nagasaki," June 1946, LC; Austin M. Brues et al., comps., *General Report of Atomic Bomb Casualty Commission, January 1947* (Washington, D.C.: National Research Council, 1947); The Committee for the Compilation of Materials on Damage Caused by the Atomic Bombs in Hiroshima and Nagasaki, ed., *Hiroshima and Nagasaki: The Physical, Medical, and Social Effects of the Atomic Bombings*, trans. Eisei Ishikawa and David L. Swain (New York: Basic Books, 1981); United States Strategic Bombing Survey, *The Effects of Atomic Bombs on Hiroshima and Nagasaki* (Washington, D.C.: Government Printing Office, 1946); *Atomic Energy Hearings S. Res. 179*, Nov 45–Feb 46; Statements by Yoshio Nishina (Institute of Physical and Chemical Research, Tokyo, Japan), 12 Aug 48 and 4 May 50, in Ms, Historical Division, Military Intelligence Section, General Headquarters, Far East Command, "Statement of Japanese Officials on World War II," copy in CMH. On medical aspects see Memo, sub: Toxic Effects of the Atomic Bomb, 12 Aug 45, OCG Files, Gen Corresp, MP Files, Fldr 5, Tab G, MDR; *Radiology in World War II*, pp. 831–919; Michihiko Hachiya, *Hiroshima Diary: The Journal of a Japanese Physician, August 6–September 30, 1945*, ed. and trans. Warner Wells (Chapel Hill, N.C.: University of North Carolina Press, 1955); Office of Civil Defense, Office of the Secretary of War (Japan), and Technical Management Office, U.S. Naval Radio, *Analysis of Japanese Nuclear Casualty Data*, comps. L. Wayne Davis et al. (Albuquerque, N.Mex.: Dikewood Corp., April 1966); United States Strategic Bombing Survey, Medical Division, *The Effects of Atomic Bombs on Health and Medical Services in Hiroshima and Nagasaki* (Washington, D.C.: Government Printing Office, 1947).

When the project's survey group reached Tinian on the sixteenth, they joined the group General Farrell had organized, which included not only Manhattan personnel but also several AAF representatives and two interpreters. Groves had designated Major Furman, who had participated in Manhattan's scientific intelligence activities in Europe, to lead a unit with a similar mission of investigating the progress of atomic research in Japan.

While the assembled survey personnel marked time in late August, General Farrell formed them into three teams. The first team going to Japan included Farrell himself, Brig. Gen. James B. Newman, Jr., of the AAF, who served as his deputy; medical and intelligence officers; and officers trained in metallurgy. In the other two teams, he included chiefly medical officers. Col. Stafford L. Warren, chief of the Manhattan District's Medical Section, commanded the Nagasaki group, while his deputy in the Medical Section, Lt. Col. Hymer L. Friedell, led the Hiroshima team.

Negotiations with the Japanese to arrange for an early entry into Hiroshima and Nagasaki culminated in formation of a special party, comprised mostly of medical personnel from the International Red Cross, the Army Medical Corps, MacArthur's staff, and the Manhattan Project. The Manhattan contingent consisted of Farrell, Newman, Warren (whom Farrell had relieved temporarily of his assignment as chief of the Nagasaki team so that he could serve as his medical consultant), and a medical and an intelligence officer. The special party, accompanied by two representatives of the Japanese government, flew into Hiroshima on 8 September. Using Geiger counters and other instruments, members of the party checked through the destroyed area of the city, determining that no significant amounts of radioactivity persisted. A Signal Corps photographer with the party took some of the first official pictures of the damage wrought by the bomb. Completing the preliminary survey in a few days, the special party (except for Farrell and Newman who had left earlier for a hurried visit to Nagasaki) returned to Tokyo.

Meanwhile, Colonel Warren's team reached Nagasaki on 17 September and began three weeks of intensive investigation of damage and injuries wrought by the bomb in that city. The group concentrated on gathering data concerning the nature of casualties. It examined survivors in the nearby Omura Naval Hospital and obtained autopsy records of those who were killed or died of injuries. A new detail of officers from the Army Medical Corps relieved Warren's team in early October, and it departed from Nagasaki on the sixth, arriving back in the United States on the fifteenth.

A series of typhoons prevented Colonel Friedell's team from reaching Hiroshima until 26 September. It had only about a week to carry out investigations designed to supplement the preliminary data collected by Farrell's party. Departing Hiroshima on 3 October, Friedell's team joined the Nagasaki group for the return trip to the United States.

Other investigative groups, some of them sponsored by the Army, also conducted surveys of the effects of the atomic bombing of Japan in late 1945 and 1946. SCAP headquarters had established a Joint Commission for the Investigation of the Atomic Bombing of Japan during the period when the Manhattan Project survey was in progress. Commission teams comprised chiefly of Army medical personnel and Japanese scientists worked closely with the Manhattan teams, which were viewed as part of the commission's survey organization. The commission's personnel continued to work in Hiroshima and Nagasaki after the departure of the Manhattan teams, extending studies begun by the bomb project groups.

The Manhattan teams also cooperated with the group sent to Japan by the United States Strategic Bombing Survey (USSBS), an organization established by the War Department in 1944. The USSBS had received a request from the President in August 1945 to conduct a study of the effects of all types of air attack in the war against Japan, including the employment of atomic bombs. In addition, the Secretary of War retained Maj. Alexander de Seversky, a well-known aviator and aeronautics engineer, to serve as his special consultant on the results of employing air power in the Pacific Theater, including the atomic bombing of Hiroshima and Nagasaki. The Navy had its own special investigative unit, the Naval Technical Mission to Japan, which collaborated with Manhattan teams. The British Mission arrived too late to work with the Manhattan groups, but cooperated with the USSBS in surveys of Hiroshima and Nagasaki in November 1945.

All of the survey groups eventually published reports of their observations and conclusions concerning the effects of the atomic bombing of Hiroshima and Nagasaki. The Manhattan District released its report on 30 June 1946, summarizing the physical damage, medical findings, and other pertinent observations made by its survey teams.

Both cities had suffered extensive physical damage to structures and other inanimate objects as a result of the tremendous blast and conflagration, the latter caused by heat from the atomic explosion, collapse of buildings, overturned stoves, shorting out of electrical systems, and spread of fire. Within a radius of 1 mile of the epicenter of the explosion, destruction in both cities was virtually complete, except for the frames of a few reinforced concrete buildings. Because of differences in topography and layout of the cities, more than 5 square miles of Hiroshima were totally devastated, while only 3 square miles of Nagasaki were similarly destroyed. In the relatively flat terrain of Hiroshima there was heavy damage to almost everything up to 2 miles from the blast center, destruction of 50 percent or more up to 3 miles, and comparatively light damage for several miles beyond, with broken glass as far away as 12 miles. In the rougher terrain of Nagasaki, severe damage extended for about 3 miles north and south in the valley where

Physical Damage at Hiroshima

the bomb had been dropped and generally shorter distances up the hillsides to the east and west, but with partial damage or fire as far as 4 miles out from the blast center at certain points.

The various survey groups were able to obtain a reasonably accurate assessment of the actual physical damage, but they all experienced greater difficulty in securing a clear picture of the effect on the inhabitants of the two cities. The Manhattan teams, for example, were handicapped by the length of time that had elapsed before they were able to enter the cities. They also found that Japanese public officials lacked precise statistical data on the actual population of the two stricken communities at the time of the bombings and on the subsequent movement of people in and out of the cities. The extensive destruction of such record-keeping civil organizations as hospitals, fire and police departments, and other government agencies further complicated the collection of accurate statistics.

Thus, the Manhattan teams had to derive most of their medical data from examining the injured; analysis of death records, including autopsy reports; and tabulation of such data as the Japanese had compiled. The District released its survey results in June 1946, including the estimate of casualties that differed somewhat from those released by other groups (*Table 3*).

TABLE 3—COMPARATIVE ESTIMATES OF ATOMIC BOMBING CASUALTIES IN WORLD WAR II

City	Population 1945	MED June 1946		USSBS March 1947		OSW (Japan) and USNR April 1966	
		Dead	Injured	Dead	Injured	Dead	Injured
Hiroshima	255,000	66,000	69,000	80,000	80,000–100,000	70,000	70,000
Nagasaki	195,000	39,000	25,000	45,000	50,000–60,000	36,000	40,000
Total	450,000	105,000	94,000	125,000	130,000–160,000	106,000	110,000

Sources: Ms, MED, "The Atomic Bombings of Hiroshima and Nagasaki," June 1946, LC; USSBS, *The Effects of Atomic Bombs on Health and Medical Services in Hiroshima and Nagasaki*; OSW (Japan) and USNR, *Analysis of Japanese Nuclear Casualty Data*. See also MDH, Bk. 1, Vol. 4, pp 6.12–6.15, DASA.

Manhattan's survey data did not mention that American prisoners of war held in a camp in Hiroshima were among the atomic bombing casualties. The Commander in Chief, U.S. Army Forces, Pacific, had received information that about twenty American airmen from the crews of airplanes shot down over Japan were killed in the bombing of Hiroshima. Subsequent information provided by Japanese officials appeared to confirm the presence of the airmen in Hiroshima on 6 August 1945.[53]

A primary objective of the Manhattan survey teams was to ascertain the particular kinds of injuries suffered, with special attention to the effects of radioactivity. By far the largest number of casualties resulted from burns traceable to the heat of the explosion and the fires generated by it and secondary causes. Other major sources of injury were falling debris, pressure of the blast, and radiation. Most radiation injuries occurred from exposure of the victims to gamma rays at the time of the explosion. There was little evidence of casualties from alpha and beta rays and from residual radioactivity in the bombed-out areas.

While giving less attention to the psychological impact, the teams nevertheless ranked terror with physical damage and human death and injury as the three most important effects of the new weapon. They particularly noted the immediate panic caused by the explosions, followed by a temporary mass exodus from the cities. Residents who had generally ignored the appearance of only one or two enemy aircraft moved promptly into air raid shelters at the slightest indication of enemy air activity overhead.

The USSBS, unlike the Manhattan survey, devoted considerable effort to trying to determine the effects of the bombs on the attitude of the Japanese people toward the war and the decision of the Japanese government to surrender. It reaffirmed the substantial adverse impact the bombs had on the morale of the local inhabitants of

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[53] See CINCAFPAC Msgs, 23 Sep and 18 Oct 45, HRC Files, 471.6 (Bombs, Atomic), CMH; Telecons, Ruth Markwood (Gen Ref Br, CMH) to Maj G. Chase (OCINFO, DA), sub: Names of Americans Killed by Hiroshima Atomic Bombing, 17 and 26 Apr 72, HRC Files, 384.5 (Aerial Attacks and Raids–Atomic Bomb), CMH; *Washington Post*, 11–12 Jul 70.

Atomic Bombing Casualties at Nagasaki

Hiroshima and Nagasaki. But the USSBS found that, in the relatively brief period between the dropping of the bombs and the start of surrender negotiations, people elsewhere in Japan had "neither time nor understanding of the revolutionary threat of the atomic bomb . . . to see in [them] a final blow to Japan's prospects for victory or negotiated peace." [54] The USSBS concluded also that, while the bombs had some impact on the leaders of the Japanese government, their knowledge of the awesome character of the new weapon seems not to have played a significant part in convincing them of the need to surrender.

The USSBS and virtually all the other survey groups that inspected the results of the attacks on Hiroshima and Nagasaki agreed with the Manhattan teams' assessment that the atomic bomb was indeed a revolutionary new device capable of inflicting damage and casualties on a scale far beyond any existing weapon available for use in modern warfare. The one dissent to this view among the survey groups came from Major de Seversky, who had made a hurried one-man inspection of Hiroshima and Nagasaki in the fall of 1945. He contended that the other survey groups had greatly exaggerated the effects of the bombs and misinterpreted the character of the destruction they had wrought. He asserted that about 200 B-29's loaded with incendiaries could have accomplished an equivalent amount of damage. Furthermore, he argued, atomic bombs dropped on modern cities, such as New York or Chicago, would do no more damage than a 10-ton blockbuster. The wide circulation of de Seversky's conclusions in newspapers and the publication of his article, "Atomic Bomb Hysteria," in the February 1946 issue of *Reader's Digest* created a public controversy. As a result, the Senate Special Committee on Atomic Energy, at work on preparing legislation for the peacetime control of the new energy source, invited de Seversky and representatives of the Manhattan Project, the USSBS, and other appropriate organizations to present their views at its 15 February session.[55]

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[54] USSBS, *The Effects of Atomic Bombs on Hiroshima and Nagasaki*, p. 22.

[55] *Atomic Energy Hearings on S. Res. 179*, pp. 473-551. The Senate in late October 1945 had established a Special Committee on Atomic Energy to deal with "problems relating to the development, use, and control of atomic energy" (ibid., p. 1). De Seversky reported to the Secretary of War on the

Continued

SURVIVORS OF THE NAGASAKI BOMBING *returning to the devastated city*

Representing the Manhattan Project at the hearing were General Farrell and Colonel Warren. Farrell concentrated on refuting de Seversky's downgrading of the psychological and physical effects of the bombing of Japan. De Seversky, he said, underestimated the psychological damage created by the instantaneousness of an atomic explosion and the lack of any effective defense against it. He challenged the accuracy of de Seversky's data on the comparative damage possible with conventional air weapons and stated that the evidence collected by the Manhattan survey teams indicated that at least 703 B-29's would be required to do the physical damage caused by the atomic bomb at Hiroshima. While expressing concern with the popular tendency to overestimate the power of the bombs, Farrell asserted that "if two bombs will do what was done to Hiroshima and Nagasaki, put two cities out of commission and stop a war, I think it is [*sic*] a fairly effective weapon." [56]

Colonel Warren generally supplemented General Farrell's testimony on the extensive physical damage, caused by fire and the blast effect, in Hiroshima and Nagasaki. He emphasized especially the difficulty of arriving at any accurate conclusions on what had actually happened on the

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results of his study of air power in the Pacific Theater in a letter dated 11 February 1946. That part of the letter which relates to the atomic bombing of Japan is reproduced in ibid., pp. 493-501.

[56] Testimony of Farrell in ibid., p. 505.

basis of observations made and information gathered in the period of a few days of hurried inspection, such as that carried out by Major de Seversky. He cited, for example, the impossibility of arriving at an accurate estimate of casualties without a great deal more investigation and analysis, as the Japanese themselves were not able to furnish reliable statistics. Because of confusion, shock, and panic, Japanese medical officials had not kept adequate records of mortalities and injuries caused by the bombs. Colonel Warren reinforced General Farrell's conclusion "that a tremendous amount of destruction occurred" and the atomic bomb had accomplished "the job it was intended to do." [57]

For the most part representatives of the USSBS and other experts supported the views expressed by Farrell and Warren. In the face of almost unanimous disagreement, de Seversky persisted in his contention that a Hiroshima-type atomic bomb was not any more effective against the stone, concrete, and brick structures in Western cities than a well-placed 10-ton blockbuster. He did concede, however, that a final understanding of the potentialities of atomic bombs as weapons of war would be possible only after a much more thorough and careful investigation and analysis of their effects on Hiroshima and Nagasaki.

Personnel of the Manhattan Project had participated in almost every aspect of the planning and preparations for employment of atomic bombs against Japan: in the decision to use the bombs against Japanese cities; in the choice of targets; in the development of an overseas base; and, finally, in the assessment of the damage wrought. The destruction of Hiroshima and Nagasaki marked their efforts with complete technical success and contributed significantly to ending World War II. Yet the respite that the project's success had afforded was momentary, for looming on the horizon was another threat to the security of the nations of the world—how to control this revolutionary new force in a peacetime environment. In face of this profound problem, the Manhattan Project would continue to operate in the emerging postwar period and its personnel would assume a role in guiding the domestic and international efforts to ensure that atomic energy would best serve the needs of mankind.

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[57] Testimony of Warren in ibid., p. 513.

PART FIVE

COMPLETING THE ATOMIC MISSION

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CHAPTER XXVII

The Atomic Age and Its Problems

Employment of an atomic bomb against Japan demonstrated to the world that atomic energy was no longer an experimental hypothesis, but a material reality. A creation of the new atomic age, this awesome weapon of mass destruction heralded the onset of a multitude of fundamental political, social, and economic problems for national leaders in the emerging postwar era. As Secretary Stimson cautioned in his memorandum to the press shortly after the bombings of Hiroshima and Nagasaki, "great events have happened. The world is changed and it is time for sober thought." [1]

Anticipating the likely ramifications of the atomic bombing mission, the leaders of the Manhattan Project in the summer of 1945 concentrated their efforts on two problem areas deemed as priority matters: releasing just enough information on the atomic project to inform the general public without violating essential military security, and participating more actively in developing the means of peacetime control of the new source of energy both at home and abroad. "The result of the bomb is so terrific," the Secretary warned in his pronouncement, "that the responsibility of its possession and its use must weigh heavily on our minds and on our hearts." [2] Even those at Trinity who had witnessed the birth of the new age had felt within moments of the first atomic explosion "their profound responsibility to help in guiding into right channels the tremendous forces which had been unlocked for the first time in history".[3]

The Atomic Story: Informing the Public

The bombing of Japan, in an instant, catapulted the Manhattan Project's closely guarded secret—development of an atomic weapon for military use—into the public limelight. This event precipitated a seemingly endless barrage of requests for information, but project leaders were prepared with official statements on selected aspects of the atomic story. "In accord with its policy of keeping the people of the nation as completely informed as is consistent with national security, the War Department wishes to make known at this time, at least in broad dimension, the story behind this tremendous weapon. . . . Other statements will be released which will give further details concerning the scientific and production aspects of the project and will give proper recognition to the scientists, technicians, and the men of industry and labor who have made this weapon possible." [4]

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[1] MDH, Bk. 1, Vol. 4, "Auxiliary Activities," Ch. 8, Press Release No. 29, Comment by Secy War on Use of Atomic Bomb, 9 Aug 45, DASA.

[2] Ibid.

[3] Ibid., Press Release No. 4, First Test Conducted in New Mexico, 6 Aug 45, DASA.

The official statements released to the public following the bombings of Hiroshima and Nagasaki were the result of a carefully designed public relations program, begun in early 1944. At this time, Manhattan's military and scientific leaders had perceived that, from the standpoint of security, the release of some selected information would make it easier to maintain the secrecy of the highly classified, patented aspects of the project. With the objective of preserving essential military security while also adequately informing the American people, the public relations program was planned along two broad lines: preparation of a series of public releases, and preparation of an administrative and scientific history of the project.

Press Releases

Responsibility for preparation of the press releases—to include public statements for the President, the Secretary of War, and other government leaders—in large measure, fell initially upon General Groves and his Washington staff. The need for professional guidance was apparent. Groves contemplated borrowing Jack Lockhart, liaison official for atomic energy matters in the Office of Censorship, but pressing job commitments made him unavailable for the assignment. Lockhart, however, suggested that Groves approach William Laurence, the well-known science reporter of the *New York Times*. Responding to the Manhattan commander's request, the managing editor of the *Times* readily agreed to release Laurence for as long as he was needed by the atomic project.[5]

During the early months of 1945, Groves cleared the way for Laurence to visit the principal atomic installations and to interview the major participants. He also arranged for Laurence to observe the final significant events in the development of atomic weapons, including the Trinity test and the bombing of Japan. With assistance from public relations personnel at each site, Laurence wrote most of the press releases on various project activities and events and then circulated them to the appropriate project officials for review.[6]

Because official releases from high-ranking members of government would constitute important pronouncements on future atomic energy policy, final responsibility for these statements was assigned to the Interim Committee. The committee agreed that Laurence should draft the statements and submit them to Arthur Page, a long-time friend and aide of the Secretary of War, for review. Page, in turn, would submit the drafts to the committee. As work progressed, the committee asked 1st Lt. R. Gordon Arneson, an officer on Stimson's staff serving as the committee's secretary, to assist Laurence and Page. The three worked first on the Trinity test press releases and then on those to be issued by the President and the Secretary of War following the bombing of Japan. At its meeting on 21 June, the committee suggested a number of changes to the preliminary drafts and formed a subcommittee, consisting of Page and a representative from General Groves's office, to redraft the statements.[7]

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[4] Ibid., Press Release No. 2, Statement by Secy War, 6 Aug 45, DASA.

[5] Groves, *Now It Can Be Told*, pp. 325–26; MPC Min, 24 Feb 45, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR.

[6] For examples of the press releases prepared by Laurence see MDH, Bk. 1, Vol. 4, Ch. 8, DASA.

After the June meeting, the burden of shaping the press releases into final form fell largely to the personal staffs of Stimson and Groves. The Secretary's staff took responsibility for coordination with the British and for securing approval of the statements by Stimson and the President. The Potsdam Conference and the defeat of Churchill in the British parliamentary elections at the end of July complicated the coordinating process, but did not result in any radical changes in the statements as earlier approved by the committee. Groves's staff prepared such additional releases as would be needed following that of the Secretary of War.[8]

As the time neared for releasing information to the public, Groves reorganized the Manhattan Project's public relations program to ensure close coordination between the public relations officers at each installation and the District's Intelligence and Security Division and to retain within his office strong control over all releases. He assigned Lt. Col. William A. Consodine, a lawyer and experienced newspaper writer who was serving as a security officer on his staff, to take charge of public relations in his Washington headquarters and also designated those officers who were to oversee public relations activities at each of the major installations. Groves emphasized the necessity for direct liaison at all times and specified, in some detail, the precise limitations on publication of information, particularly on that relating to scientific matters. As a guide for the public relations officers, the Manhattan commander provided the district engineer with a specific list of those subjects that were to be omitted from all releases and outlined the mechanics for clearing material for publication, photographs, motion pictures, and radio.[9]

When authorized, the release of prepared statements was carefully controlled and adroitly managed. Within sixteen hours of the Hiroshima bombing, the President announced to the American public: "It is an atomic bomb. It is a harnessing of the basic power of the universe. The force from which the sun draws it[s] power has been loosed against those who brought war to the Far East." After giving the people a brief glimmer into the atomic story, he continued that "science and industry worked under the direction of the United States Army . . . [to effect] the greatest achievement of organized science in history [and that] the Secretary of War, who has kept in personal touch with all phases of the project, will immediately make a public statement giving further details."[10] The release of Stimson's statement came shortly after the President's. In it he provided selected facts on Manhattan's atomic activities and promised that "every effort is being bent toward assuring that this weapon and the new field of science that stands behind it will be employed wisely in the interests of the security of peace-loving nations and the well-being of the world."[11]

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[7] See Ch. 26 on the establishment and membership of the Interim Committee. Interim Committee Log, 9, 14, 19 May and 15, 18, 20–21 Jun 45, HB Files, Fldr 98, MDR; Notes on Interim Committee Mtgs, 14 May and 1 and 21 Jun 45, HB Files, Fldr 100, MDR. See also Notes on Interim Committee Mtg, 18 May 45, OCG Files Gen Corresp, Groves Files, Fldr 3, Tab O, MDR.

[8] Interim Committee Log, 21, 26 Jun and 1, 5–7, 10–11, 19, 28 Jul 45, MDR; Notes on Interim Committee Mtg, 6 Jul 45, MDR; Memo, Conant and Bush to Harrison, 25 Jun 45, HB Files, Fldr 79, MDR; Memo, Arneson to Harrison, 25 Jun 45, HB Files, Fldr 100, MDR; Memo, [Rogers Makins (British embassy staff member in Wash., D.C.) to Harrison], 16 Jul 45, OCG Files, Gen Corresp, MP Files, Fldr 12, Tab S, MDR. The exchange of messages (30 Jul–6 Aug 45) between the President and the Secretary of War concerning last-minute changes in the President's statement are in HB Files, Fldr 64, MDR.

[9] Ltr, Groves to Dist Engr, sub: MED Pub Rels Prgm, 26 Jul 45, Admin Files, Gen Corresp, 000.71 (Releasing Info), MDR.

In the press releases that followed in the days before and after the bombing of Nagasaki, the American people learned the truth about the "explosion" at Trinity and significant aspects about harnessing atomic energy and its future applications. They also received selected background information on Manhattan's atomic processes, production plants, communities, and significant personalities, both military and civilian. From a public relations standpoint, War Department and Manhattan Project officials could view their well-planned and well-orchestrated program of public releases as a substantial success. While unfolding the drama of the atomic story in surprisingly detailed episodes, the program managed to adhere to its central objective, the preservation of essential military security.

The Smyth Report

In the course of the development of the atomic bomb, a number of the scientific leaders of the project—notably James B. Conant, Vannevar Bush, Arthur Compton, and Henry D. Smyth—foresaw the need to release to the public, as soon as an atomic weapon was used, a report of some type that recounted the technical accomplishments of the wartime project. General Groves went along with this proposal, perceiving that the release of carefully selected information would make maintaining the secrecy of the rest easier. Consequently, in early April 1944, Groves conferred with Conant and Smyth concerning the preparation of a report for ultimate public release.

A short time later, after further consideration of the proposed idea, Groves requested Smyth to undertake the task of preparing the report. Both Groves and Conant viewed the Princeton University physicist as an excellent choice. He had been associated with the project in various capacities since 1941, starting as a member of the Uranium Section of the National Defense Research Committee (NDRC) and its successor organizations, then serving as a division head

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[10] MDH, Bk. 1, Vol. 4, Ch. 8, Press Release No. 1, Statement by President of the United States, DASA.

[11] Ibid., Press Release No. 2, DASA.

General Groves *(center left)* Holding a Press Conference *at District headquarters*

and associate director of the Metallurgical Laboratory, and was currently acting as a consultant to the University of Chicago program. On 21 April, Smyth informed Groves that he would be happy to accept the responsibility for the assignment, and in May the Military Policy Committee approved both preparation of the report and the selection of Smyth as its author.[12]

From the outset, General Groves made a special effort to facilitate Smyth's work. Manhattan provided him secretarial service and guards for his Princeton office, and Groves cleared security barriers so Smyth could visit the various project sites, confer with key personnel, and examine pertinent documents. In a letter to all heads of the major Manhattan installations, Groves wrote: "The purpose is to give clearly and promptly recognition to those who have worked so long and necessarily so anonymously. . . . To accomplish his purpose, Dr. Smyth must have rather complete information concerning your phase of the project including access to necessary documents . . . [and] information and advice from you and your principal assistants."[13]

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[12] Ltrs, Bush to Conant, 9 May 44, and Conant to Bush, 15 May 44, OSRD; Groves Diary, 10 Apr 44, LRG; Ltrs, Groves to Smyth, 17 Apr 44, and Smyth to Groves, 21 Apr 44, Admin Files, Gen Corresp, 319.1 (Smyth), MDR; MPC Min, 10 May 44, MDR; Hewlett and Anderson, *New World*, p. 368; Groves, *Now It Can Be Told*, p. 348. Except as otherwise indicated, section that follows on Smyth *Report* based on MDH, Bk. 1, Vol. 4, Ch. 13, DASA.

[13] Ltr, Jean O'Leary (for Groves) to Dist Engr, sub: Info for H. D. Smyth, 13 May 44, Admin Files, Gen Corresp, 319.1 (Smyth), MDR. Similar letters to Oppenheimer, Lawrence, Urey and Matthias may be found in the same file.

As Professor Smyth progressed with his work, Groves, in effect, became the coordinator of the project. Whenever Smyth needed assistance, he applied for it directly to the Manhattan commander. For example, Groves in the fall of 1944 approved his request to employ a fellow Princeton physicist, Lincoln G. Smith, as a research assistant. And, in December, he again aided Smyth in obtaining information about the thermal diffusion program, emphasizing that "it is particularly important . . . that proper credits be given to the Navy and to Abelson and Gunn." [14]

Starting as early as August 1944, Smyth began submitting draft sections to Groves and completed eleven of thirteen projected chapters by January 1945. In late February, he delivered the manuscript to Groves, lacking only a concluding chapter that would "not be a very serious undertaking." In March, Conant and Groves undertook a preliminary review of the manuscript. After a close scrutiny, they determined that Smyth's treatment was too technical, did not mention enough names of participants, included too many of the author's own critical comments on events, and provided too much information about the work at Los Alamos.[15]

As the time grew near when the report had to be ready for release, Groves arranged for an elaborate and thorough review. He gave the heads of the major project installations and the leading contractor firms an opportunity to comment on the parts of the report that pertained to their activities. After Smyth incorporated whatever revisions these comments made necessary, Groves turned over the entire manuscript to his trusted scientific adviser, Richard Tolman, for a final review and editing. Two scientists in Tolman's NDRC office—Paul C. Fine, a physicist from the University of Texas, and William S. Shurcliff, Tolman's technical assistant—aided in the final editing.[16]

To guide the reviewers on the key issue of security, Groves had Smyth and Tolman draw up a set of rules. There was a general exclusion of everything concerning actual construction of an atomic bomb. Other information could be included if it satisfied at least one of the requirements in each of the three categories set forth by Smyth and Tolman:

> I. (A) That it is important to a reasonable understanding of what had been done on the project as a whole or (B) That it is of true scientific interest and likely to be truly helpful to scientific workers in this country and

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[14] On the assignment of Smith, who finally joined the project in the spring of 1945, see Ltrs, Smyth to Groves, 31 Aug 44, and Groves to Smyth, 9 Apr 45. On the Navy and thermal diffusion see Ltrs, Smyth to Groves, 31 Nov 44, and Groves to Smyth, 11 Dec 44 (source of quotation). All letters in Admin Files, Gen Corresp. 319.1 (Smyth), MDR. Groves Diary, 6 Apr 45, LRG.

[15] Ltrs, Smyth to Groves, 5 Aug 44 and 13 Jan (source of quotation), 23 Feb, 23 Mar 45, Admin Files, Gen Corresp, 319.1 (Smyth), MDR; Groves Diary, 31 Mar 45, LRG.

[16] Oppenheimer's letter to Smyth, 14 Apr 45, provides a good example of the review comments by project leaders. The letters exchanged between Groves and Roger Williams of Du Pont on 12 Apr and 3 May 45 are representative of those received from industrial firms involved in the atomic project. On the provisions for the final review and editing of the manuscript see Ltr, Smyth to Groves 22 May 45. These letters are filed in Admin Files, Gen Corresp. 319.1 (Smyth), MDR. See also Groves Diary, 18 Jun 45, LRG.

Henry D. Smyth *(right) conferring with Richard Tolman*

> II. (A) That it is already known generally by competent scientists or (B) That it can be deduced or guessed by competent scientists from what is already known, combined with the knowledge that the project was in the overall successful or
>
> III. (A) That it has no real bearing on the production of atomic bombs or (B) That it could be discovered by a small group (15 of whom not over 5 would be senior men) of competent scientists working in a well-equipped college lab in a year's time or less.[17]

The Smyth-Tolman security rules resulted in many more changes in the draft manuscript. Nevertheless, Tolman and his editorial staff had completed their work by early July. Finally, to make certain that Smyth had given recognition in the report to all project personnel deserving it (Groves was convinced that this was the best means for avoiding future security violations), the Manhattan commander arranged for couriers to deliver selected chapters to appropriate project scientific personnel for a hurried final review. Given only a few hours, in most instances, to complete this review, the majority of the scientists simply signed a statement indicating that they approved the portion of the report they had received without making detailed suggestions. One exception was Colonel Nichols, who predicted the report would arouse "controversy concerning the fairness of credit given to different individuals. . . ." He also found that it gave too much attention to the work of the

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[17] The quoted material is from Ltr, Groves to Smyth, 21 May 45, OCG Files, Gen Corresp, MP Files, Flder 12, Tab N, MDR. See also Groves, *Now It Can Be Told*, p. 349.

Metallurgical Laboratory and to those activities in which Professor Smyth was a participant, and not enough to the commercial firms and to Los Alamos. For these reasons, the district engineer recommended that "if the report is issued in its present form, full credit be given to H. D. Smyth for preparing it and that the statement be made that the Army has no responsibility for the report except for asking him to do it." In the report as ultimately published Nichols's first recommendation was accepted; the second was not.[18]

Once again Tolman and Smyth reviewed the report to make certain that every section conformed to the established security rules, while Groves assembled a corps of stenographers, some of whom had to be flown from Oak Ridge, to do the final typing. By the end of July, the manuscript was ready to go to the printers. But a final hurdle remained: obtaining the approval of the Secretary of War—and probably the President—and, because of interchange, at least tacit approval from the British.[19]

Stimson had come back from the Potsdam meeting on 28 July. In the days following his return, the Secretary gave immediate attention to a number of urgent issues on his accumulated agenda. Initially, he devoted considerable time to consultations with his two assistants, Harvey Bundy and George Harrison, as well as other staff members, and General Groves on the subject of ongoing preparations of the public statements to be made by the President and himself after the first bomb drop. Then on the morning of 2 August, he turned to the question of publication of Smyth's manuscript. Present at the meeting in his office were Harrison and Bundy; his military aide, Col. William H. Kyle; Groves, Conant, and Tolman as project representatives; Sir James Chadwick, leader of the contingent of British scientists assigned to the project; and Roger Makins, the member of the British embassy staff in Washington assigned responsibility for atomic energy matters.

For almost two hours, the conferees discussed the advantages and disadvantages of releasing what Stimson called "the proposed statement to be made by the scientists. . . ." Conant and Groves argued strongly for publication and release as the best means for protecting the future security of the American program. Groves, in particular, saw an analogy between the information in Smyth's manuscript and "similar instruction given people going west years ago when they were told that they should go to a water hole about 30 miles away and that if it was dry they should go to one about 10 miles beyond that."[20] His point was that it provided facts about the atomic project without revealing any vital secrets.

Stimson, having just returned from

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[18] Ltr (source of quotations), Nichols to Groves, sub: H. D. Smyth Ms, 25 Jul 45; Memo, Fine to Consodine, sub: Msg for H. D. Smyth, 11 Jul 45; Memo, Consodine (for Groves) to Compton, Urey et al., sub: Instrs on Review of Smyth Ms, 13 Jul 45; Ltr, Urey to Groves, 14 Jul 45; Msg, Oppenheimer to Groves, 31 Jul 45. All in Admin Files, Gen Corresp, 319.1 (Smyth), MDR. For Groves's views see *Now It Can Be Told*, p. 349. Groves Diary, Jul 45, LRG, contains entries that serve as a guide to the final review process of Smyth's manuscript.

[19] Groves, *Now It Can Be Told*, pp. 349–50.

[20] First quotation from Stimson Diary, 2 Aug 45, HLS. Second quotation from notes on Smyth Ms Mtg in Secy War Office, 2 Aug 45, OCG Files, Gen Corresp, MP Files, Fldr 12, Tab O, MDR.

disquieting face-to-face encounters with Soviet representatives at Potsdam, expressed serious doubts about releasing any information that would be helpful to the Russians. Chadwick, who had not yet read the manuscript, also had reservations. He found difficulty in understanding why the atomic leaders in America saw the need to publish such an extensive statement, something he said that the British would not do. Makins stated that Sir John Anderson, the British Cabinet officer in charge of atomic energy, was convinced of the need for issuing a report, but he feared its cumulative impact. The meeting closed with Stimson indicating "that he was practically prepared to accept" publication, relying upon the counsel of his advisers, "because of my confidence in the conservatism of General Groves." Nevertheless, he concluded that publication should not take place until both the President and the British had approved of it.[21]

The following day Stimson dispatched a cable to the President, stating that on the unanimous advice of his advisers he had decided to recommend the release of the report for reasons of future security. While awaiting an opportunity to see the President, Chadwick, who in the meantime had read the report, sent an acknowledgment that he could see the necessity for its release. When the Secretary finally saw Truman on 8 August, two days after the bombing of Hiroshima, he advised him that he should make the decision, as "he would have to bear the brunt of the disapproval of Congress for giving away such a valuable secret." After hearing the views of Bush, Conant, Groves, Stimson, Harrison, and Admiral William D. Leahy, his personal chief of staff, at a White House meeting on the ninth, Truman decided in favor of immediate publication.[22]

On 12 August, the War Department released the first of a thousand copies of the report entitled *A General Account of the Development of Methods of Using Atomic Energy for Military Purposes Under the Auspices of the United States Government, 1940–1945*, which Groves had printed earlier by the Pentagon's classified reproduction facilities in anticipation of the President's approval. Issued with each copy of the report was an accompanying statement that sought to place its publication in the proper perspective:

> Nothing in this report discloses necessary military secrets as to the manufacture or production of the weapon. It does provide a summary of generally known scientific facts and gives an account of the history of the work and of the role played in the development by different scientific and industrial organizations.
>
> The best interests of the United States require the utmost cooperation by all concerned in keeping secret now and for all time in the future, all scientific and

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[21] Stimson Diary (source of quotation), 2 Aug 45, HLS; Notes on Smyth Ms Mtg in Secy War Office, 2 Aug 45, MDR; Groves Diary, 27 Jul and 2 Aug 45, LRG; Ltrs, Tolman to Groves, subs: Status of Smyth Hist, 26 Jul 45, and Conversation This Morning With Chadwick Re Symth Hist, 27 Jul 45, Admin Files, Gen Corresp, 319.1 (Smyth), MDR.

[22] Stimson Diary (source of quotation), 9 Aug 45, HLS; Msg, Secy War to President, 3 Aug 45, HB Files, Fldr 64, MDR; Groves Diary, 9 Aug 45, LRG; Bush, *Pieces of the Action*, pp. 294–95. On Chadwick's views see Ltr, Chadwick to Field Marshal Henry Maitland Wilson (head of British Joint Staff Mission, Wash., D.C.), 4 Aug 45, OCG Files, Gen Corresp, MP Files, Fldr 12, Tab H, MDR.

technical information not given in this report or other official releases of information by the War Department.[23]

While the Smyth *Report*—as it came to be popularly known—achieved its basic purposes of informing the American public without compromising vital project secrets, there were inevitably objections and criticisms on some points. Where appropriate, Professor Smyth made corrections and additions for incorporation in later printings. But none of these corrections and additions greatly altered the original report, which, as Groves noted in retrospect, was "on the whole, . . . considering the rather difficult conditions under which it was prepared, . . . extraordinarily successful in its efforts to distribute credit fairly and accurately."[24]

Professor Smyth himself felt the report achieved considerably more than this limited objective. In his view the development of the atomic bomb had raised many questions on postwar atomic energy policy "that must be answered in the near future . . . by the people through their representatives." In accomplishing this, Smyth looked to the men of science, "who can understand . . . and explain the potentialities of atomic bombs to their fellow citizens," to use his report as the vehicle for helping the public gain some insight into the new atomic world. "The ultimate responsibility for our nation's policy rests on its citizens," Smyth wrote, "and they can discharge such responsibilities wisely only if they are informed."[25]

Atomic Energy: Planning for Postwar Control

Release of selected information was only one aspect of the much larger problem of planning for peacetime legislation and international agreements to control the use of atomic energy in the postwar era. When President Truman, in a message to Congress on 3 October 1945, emphasized the importance of dealing with this problem on "two fronts—the domestic and international," he focused attention upon a matter that had long been a cause of considerable concern for atomic project leaders and their scientific staffs.[26]

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[23] WD, Bur of Pub Rels, Press Branch, Press Release, 12 Aug 45, Admin Files, Gen Corresp, 319.1 (Smyth), MDR. The release also made an addition to the text of the Smyth *Report* at paragraph 12.18, which was intended to allay public anxiety concerning the dispersal of radioactivity by the bomb: "The War Department now authorizes the further statement that the bomb is detonated in combat, at such a height above the ground, as to give the maximum blast effect against structures, and to disseminate the radioactive products as a cloud. On account of the height of the explosion practically all the radioactive products are carried upward in the ascending column of hot air and dispersed harmlessly over a wide area. Even in the New Mexico test, where the height of explosion was necessarily low, only a very small fraction of the radioactivity was deposited immediately below the bomb." A copy of the release is reproduced in Groves, *Now It Can Be Told*, pp. 351–52.

[24] Groves, *Now It Can be Told*, p. 352. Typical examples of the reaction to the publication of the Smyth *Report* may be found in Admin Files, Gen Corresp, MDR. See 319.1 (Smyth) for Ltrs, August C. Klein (Y–12 Proj Engr, Stone and Webster) to Smyth, 30 Aug 45, and Smyth to Boris Pregel (Canadian Radium and Uranium Corp.), 14 Sep 45; and 095 (Metal Hydrides) for Ltrs, P. P. Alexander (Metal Hydrides president) to Groves, 19 Sep 45, Groves to T. Lindsley (Metal Hydrides), 5 Dec 45, and Alexander to Irvin Stewart (OSRD Ex Secy), 12 Jan 46. In the privately published Princeton University edition (1945) of the report, Smyth added appendices giving the texts of the War Department's release on the Trinity test of 16 Jul 45 and the statements issued by the British Information Service on 12 August and the Canadian Information Service on 13 August.

[25] Smyth *Report*, pp. v and 165.

Wartime Background

As many of the scientists completed the basic research work required to achieve the wartime objectives of the atomic program, they began to consider the future possibilities in the exciting new field of atomic energy. The situation in the Metallurgical Project was typical. In the latter part of 1943, rumors spread of an impending release of numerous personnel. To counter the disquieting effects of these rumors on his scientific staff, Arthur Compton included in his new program for the coming fiscal year basic research projects as well as continuing support for the Hanford and Los Alamos operations.

For the most part, Groves and his scientific advisers opposed having Metallurgical Project scientists undertake any new large-scale or long-range research activities until the war was over, but they could see the necessity for limited research projects for those scientists serving in a standby capacity for the plutonium production facilities and the bomb development program. This concept of limited research generally did not satisfy most Metallurgical Project scientists. Accordingly, Compton endeavored to reduce their unrest by giving them an opportunity to participate in postwar planning. In July 1944, he appointed a committee to formulate "sound national postwar policies . . . from the military, scientific and industrial standpoint." This committee issued in November a "Prospectus on Nucleonics." It discussed in detail future research and industrial applications of atomic energy in the United States and the need for a world organization to prevent nuclear warfare.[27]

By August, the Military Policy Committee had also approved appointment of a special committee, suggested by Bush and Conant, "to recommend from a technical standpoint the postwar policy for governmental research and development in the atomic energy field." Groves, who later stated that a prime purpose of this committee was to convince project scientists that the Army was not forgetting postwar problems, appointed Tolman as chairman, with Warren K. Lewis, Henry D. Smyth, and Rear Adm. Earle W. Mills, assistant chief of the Navy's Bureau of Ships, as members. Capt. Thorvald A. Solberg of the Navy also sat in on all meetings.

This Postwar Policy Committee, as it came to be called, interviewed scientists from all of the major Manhattan Project research centers and received a large number of written memorandums. The committee, seeing the need for maintaining United States military superiority, recommended continued production of active materials and weapon development and government support of fundamental research and industrial applications. To administer the program, the committee proposed a national authority that, in the manner of the Office of Scientific Research and Development (OSRD), would make funds available to government-operated military and civilian laboratories, colleges and universities, and commercial firms.[28]

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[26] Truman, *Memoirs*, 1:530.

[27] "Prospectus on Nucleonics," prepared by Zay Jeffries (committee chairman), Enrico Fermi, James Franck, Thorfin R. Hogness, Robert S. Mulliken (secretary), Robert S. Stone, and Charles A. Thomas. The covering communication from which the quotation in the above paragraph was taken is Ltr, Jeffries, Fermi et al., to Compton, 18 Nov 44, HB Files, Fldr 59, MDR. A copy is also on file in Admin Files, Gen Corresp, 334 (Postwar Policy Committee–CEW). Hewlett and Anderson, *New World*, pp. 324–25. Fermi's wife states that Metallurgical Laboratory physicist Eugene Rabinowitch also had an important hand in drafting the report on nucleonics, although he was not a member of the committee; see Laura Fermi, *Illustrious Immigrants: The Intellectual Migration From Europe, 1930–1941* (Chicago: University of Chicago Press, 1968), p. 201. Rabinowitch later became the editor of the *Bulletin of the Atomic Scientists*.

Another individual gravely concerned with postwar planning was Niels Bohr, the eminent Danish physicist who had escaped from his occupied homeland in 1943. In conversation with Soviet officials at the Soviet embassy in London in April 1944, Bohr had learned that the Soviets had heard rumors of the Manhattan Project and were very much interested in the program. He concluded that Russia would continue to push development of atomic energy and, considering the quality of the prewar work of Soviet physicists added to the knowledge they might gain from a defeated Germany, he thought they would succeed. Bohr advocated that the United States and Great Britain should adopt an open atomic policy after the war, using the revolutionary new development to achieve effective international relations with the Soviet Union. Meeting with Churchill in April and Roosevelt in August, the Danish scientist zealously conveyed his convictions to both of the wartime leaders. Bohr experienced little success in communicating his ideas to Churchill, but he received a much more sympathetic hearing from Roosevelt, who promised to take up the matter with Churchill at their next meeting.[29]

Roosevelt next met with Churchill in early September at the OCTAGON Conference in Quebec,[30] called to plan for the final campaigns against Germany and joint operations against Japan, but it apparently was not until Churchill's two-day visit to Hyde Park following the conference that the two leaders discussed Bohr's proposals. With Admiral Leahy present, they considered the Danish scientist's suggestions for ending the secrecy of the bomb and negotiating an agreement with Russia to avoid a postwar arms race, but decided that his ideas were premature. They then turned to postwar Anglo-American atomic relations, including the possibilities of industrial application, which Churchill perceived could contribute to British economic recovery, a subject he had discussed with Roosevelt at Quebec.

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[28] MPC Min (source of quotation), 5 Aug 44, OCG Files, Gen Corresp, MP Files, Fldr 23, Tab A, MDR; Ltr, Groves to Tolman, 29 Aug 44, and Memo, Tolman to Lawrence, sub: Committee on Postwar Recommendations, 16 Sep 44, Admin Files, Gen Corresp, 334 (Postwar Policy Committee, Corresp), MDR; Rpt, Postwar Policy Committee, 28 Dec 44, OCG Files, Gen Corresp, Groves Files, Fldr 3, Tab A, MDR; Memo, Groves to Harrison, 19 Jun 45, OCG Files, Gen Corresp, Groves Files, Fldr 3, Tab H, MDR; Hewlett and Anderson, *New World*, pp. 324–25.

[29] Bohr visited the Soviet embassy in London in April 1944 to pick up a letter from Peter Kapitza, the Russian physicist who had been a member of Ernest Rutherford's research team at Cambridge University's Cavendish Laboratory in the 1920's. Kapitza, upon hearing of Bohr's escape from Denmark, wrote to invite him to come with his family to the Soviet Union to continue his scientific work. For a detailed description of this and other aspects of Bohr's activities in the spring and summer of 1944 see Gowing, *Britain and Atomic Energy*, pp. 346–48. See also Memo, [Bohr], 3 Jul 44, and Ltr, Bush to Bundy, 25 Apr 45, with inclosure by Felix Frankfurter, HB Files, Fldr 19, MDR.

[30] For a detailed account of the OCTAGON Conference see Matloff, *Strategic Planning for Coalition Warfare*, Ch. XXIII.

Agreeing that the wartime atomic partnership should continue after the war, the Prime Minister and the President recorded their views in a brief *aide-memoire,* typed on Churchill's official stationery and initialed in red ink by both leaders. In it they rejected any immediate announcement of the existence of the Manhattan Project and called for continuing "the utmost secrecy"; they recommended that the bomb "might perhaps, after mature consideration, be used against the Japanese, who should be warned that this bombardment will be repeated until they surrender"; and they agreed that "full collaboration between the United States and the British Government in developing Tube Alloys for military and commercial purposes should continue after the defeat of Japan unless and until terminated by joint agreement." For the two leaders, the *aide-memoire* constituted a preliminary statement of their hopes and fears concerning future use and control of the newly evolving revolutionary source of energy, especially in its application to development and proliferation of nuclear weapons.[31]

Meanwhile, Bush and Conant, undoubtedly influenced by the growing unrest among project scientists as well as by the progress of the war in Europe, also sought to instigate planning for postwar control and use of atomic energy. The day after the Hyde Park meeting (about which they knew nothing), the two scientific leaders wrote to Secretary Stimson, pointing out that the time was approaching when the public would have to be informed about atomic developments during the war and when national legislation would have to be enacted and diplomatic measures taken. Release of information, preferably in the form of a detailed history, would become essential, they believed, either when the bomb was used against the enemy or, if Japan surrendered before that happened, when the war ended. Basic atomic knowledge, they warned Stimson, could not be kept secret and for a government to assume that by doing so it would become secure "would be extremely dangerous." The Secretary, Bush and Conant suggested, should talk to the President about drafting legislation to establish a "national commission" and a treaty with Great Britain and Canada that would continue and extend the wartime arrangements for interchange of technical information.[32]

Three days later, Bush received an unexpected summons to the White House to bring the President up-to-date on atomic developments. When

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[31] *Aide-memoire,* Roosevelt and Churchill, sub: Tube Alloys, 18 Sep 44, FDR. Admiral Leahy, in his account of the Hyde Park meeting, states that the *aide-memoire* was signed on 19 September, but this appears to be incorrect. See William D. Leahy, *I Was There* (New York: Whittlesey House, McGraw-Hill Book Co., 1950), pp. 265–66. This account of the atomic discussions at Hyde Park is based on Ms, "Diplomatic Hist of Manhattan Proj," pp. 33–34, HB Files, Fldr 111, MDR; Winston S. Churchill, *The Second World War: Triumph and Tragedy* (Boston: Houghton Mifflin Co., 1953), 160–62; Groves, *Now It Can Be Told,* pp. 401–02; Hewlett and Anderson, *New World,* pp. 326–28; Gowing, *Britain and Atomic Energy,* pp. 358–60 and 447 (App. 8 gives text of the *aide-memoire*).

[32] Memo, Bush and Conant to Secy War, sub: Release of Info to the Public, 19 Sep 44, HB Files, Fldr 108, MDR.

Roosevelt introduced Bush to Lord Cherwell, Churchill's scientific adviser, and Admiral Leahy and then began talking generally about the bomb and interchange with the British without regard to Cherwell's continued presence, the OSRD director became aware that the President had been carrying on freewheeling discussions with Churchill, Bohr, and others without benefit of consultation with his regular advisers on atomic matters. Without mentioning the *aide-memoire*, Roosevelt stated that he had talked to Churchill about complete interchange as a way of keeping Britain strong after the war. Greatly concerned by Roosevelt's indication that he was plunging ahead with postwar planning for atomic energy without sufficient guidance from those with an expert knowledge of atomic matters, Bush suggested that the President should have a talk with Stimson. Roosevelt agreed, but when Bush proposed to Stimson three days later (25 September) that he point out to the President the dangers of an international armaments race if Russia were not permitted to share in the interchange of scientific data, the Secretary demurred. He did not think, he told Bush, that he could hold the President's attention long enough to impress upon him the seriousness of the prospect. Bush then suggested that he and Conant prepare a statement on international control that Stimson could then pass on to the President. The Secretary consented to this arrangement.[33]

Bush and Conant submitted a statement on the "salient points concerning future international handling of [the] subject of atomic bombs" on 30 September. They elaborated in some detail "on the international post-war aspects . . . of great importance to the future peace of the world" and predicted a successful demonstration of an atomic bomb capable of a blast damage equivalent to 1,000 to 10,000 tons of ordinary explosives before 1 August 1945. But, they continued, this enormously powerful weapon was only the first step in "an expanding art." The future was likely to bring development of a "super-super bomb" using heavy hydrogen that would produce blast damage equal to that of "1,000 raids of 1,000 B-29 Fortresses delivering their load of high explosives on one target." Because any nation having the necessary technical and scientific resources could produce in three or four years atomic bombs equivalent to those the United States and Great Britain would soon have, the advantage held by these two countries was only temporary.[34] Given the ever-present possibility of "the accidents of research," another country might attain as great a temporary advantage as the United States and Great Britain then held. Nor was a continuing policy of complete secrecy after the war likely to prevent other countries from producing nuclear weapons, for all the basic scientific facts necessary to do so already were known to physicists.

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[33] The President apparently had turned over his copy of the *aide-memoire* to his file room without ever mentioning its existence to anyone associated with the Manhattan Project. Not until after Roosevelt's death in April 1945 did Manhattan leaders learn of the *aide-memoire* from British sources, and not until a decade later was the original American copy discovered, misfiled, in the Roosevelt papers, FDR. See also Conference Memo, Bush, 22 Sep 44; Memos, Bush to Conant, 23 and 25 Sep 44. All in OSRD. Hewlett and Anderson, *New World*, pp. 326–29. Stimson Diary, 25 Sep 44, HLS.

[34] The prediction of Bush and Conant as to how long other nations having the requisite resources would require to produce an atomic bomb equivalent to that developed by the United States in 1945 proved to be amazingly accurate. President Truman announced in September 1949 that the Soviet Union had achieved an atomic explosion, only slightly more than four years after the Americans had set off the first such explosion at Alamogordo in July 1945. See *New York Times*, 24 Sep 49.

Hence, the soundest policy was to disclose completely, as soon as the first bomb had been demonstrated, the history of its development in the United States, keeping secret only "manufacturing and military details." Complete secrecy was certain to result in an international armament race, with secret development in the Soviet Union and other countries. Not even control of most of the world's supply of uranium and thorium would prevent development of the super-super bomb, using heavy hydrogen, the supply of which is virtually unlimited. The wisest solution for the postwar period was "free interchange of all scientific information on this subject . . . under the auspices of an international office that derived its power from whatever association of nations is developed at the close of the present war. . . . Under these conditions," Bush and Conant concluded, "there is reason to hope that the weapons would never be employed and indeed that the existence of these weapons might decrease the chance of another war.[35]

The Bush-Conant statement brought no immediate reaction from Stimson. Toward the end of October, the Secretary talked to Bush about some of the points made in it, but he did not indicate what action he intended to take. Bush's own view at the time was that Stimson should comment on the points and then send them on to the President. Foreshadowing the ultimate establishment of the Interim Committee, the OSRD chief also suggested that Roosevelt was going to need an advisory group to guide him in reaching decisions on atomic matters, but he felt the time was not quite propitious yet for suggesting it to the President. Harvey Bundy also proposed such a group. He visualized a six-man commission comprised of a representative of the Secretary of War, the Secretary of State, and the Secretary of the Navy, and three scientists familiar with the atomic project. After atomic weapons had been used, this commission would assist the President in preparing a brief public statement about the importance and characteristics of atomic energy and in outlining a program for its temporary and its permanent control in the United States.[36]

Not until early December did Bush have another opportunity to broach the subject of future atomic energy problems at the War Department. On the eighth, at a meeting with Bundy and John J. McCloy, the Assistant Secretary of War, Bush suggested that the President should immediately nominate an advisory group to prepare press releases, draft legislation, and advise on the development of a postwar experimental program, emphasizing the need for bringing the Department of State into the planning for the international aspects of atomic energy. Subsequently, both Bundy and Bush briefed Stimson on the substance of the discussion. While agreeing that the State Department had to be informed soon, Stimson was still not ready to make decisions on an advisory committee or international exchange. Months would pass before he reached a decision on either matter.[37]

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[35] Quotations in paragraphs on Bush-Conant statement from Memo, Bush and Conant to Secy War, sub: Salient Points Re Future International Handling of Atomic Bombs, 30 Sep 44, Incl to Ltr, same addressees, same date, HB Files, Fldr 69, MDR. Copies of the letter are also in OCG Files, Gen Corresp, MP Files, Fldr 10, Tab A, and Fldr 26, Tab L, MDR.

[36] Hewlett and Anderson, *New World*, p. 330; Memo, Bush to Conant, 24 Oct 44, OSRD; Memo, Bundy to Secy War, 16 Nov 44, HB Files, Fldr 108, MDR.

After Roosevelt's death, Stimson went to Truman with a suggestion to appoint an advisory group on atomic energy. The resulting Interim Committee, which began meeting in May, did not take up the discussion of postwar legislation for domestic control of atomic energy until July. On the nineteenth, the committee considered the first draft of an atomic energy bill, prepared by two War Department lawyers—Brig. Gen. Kenneth C. Royall and William L. Marbury. Under guidance from George Harrison and with technical assistance from the Manhattan District, Royall and Marbury in drawing up the draft bill had included the Bush-Conant proposals and incorporated the basic premise that, in the postwar period, atomic energy would have to continue to receive substantial federal support and remain under strong federal control.[38]

Many provisions seemed closely patterned after the wartime program, including continuation of essentially military control with no significant relaxation of security restrictions on research and development activities. The nine-man commission proposed by the bill—five civilians, two representatives of the Army and two of the Navy—resembled the Military Policy Committee. The commission was to be a part-time advisory group, whose members could hold other government positions and would receive no compensation. Assisting the commission would be four advisory boards on military applications, industrial uses, research, and medicine, each comprised of technical experts appointed by the commission. Serving the commission would be a full-time staff headed by an administrator and deputy administrator, an arrangement not unlike that of Groves and Nichols in the Manhattan Project, particularly because the commission could delegate all of its powers to these officials.

The extensive powers granted to the commission—in this Royall and Marbury followed the earlier suggestions of Bush and Conant—were similar to those held by the Army in the wartime program. They included custody of raw materials, facilities and equipment, technical information and patents, and all contracts and agreements related to production of fissionable materials. As in the Manhattan Project, the administrator would have authority to carry on atomic research in commission-owned facilities or to have it done by other institutions under contract. For this or any other commission activities, he would have broad powers to acquire property, facilities, or services. The commission would administer its own security, personnel, and audit regulations. Finally, the bill provided that the commission would direct, supervise, and regulate all atomic activities, even those pursued by outside organizations.[39]

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[37] Conference Memo, Bush, 8 Dec 44; Memo, Bush to Conant, 13 Dec 44. Both in OSRD. Hewlett and Anderson, *New World*, pp. 330–31.

[38] Royall-Marbury draft bill, 18 Jul 45, HB Files, Fldr 77, MDR (copy also in OSRD); Notes on Interim Committee Mtg, 19 Jul 45, MDR; Hewlett and Anderson, *New World*, pp. 412–14.

Bush and Conant felt that the two War Department lawyers had granted the commission more sweeping powers than were needed for a peacetime organization. They also proposed, and Groves and Harrison agreed with them, that only civilians should be members of the commission. Harrison noted that the armed services would be adequately represented on the advisory board on military applications.[40]

The War Department asked General Royall to revise the bill on the basis of the comments made by Manhattan leaders and Interim Committee members. With the objective of making only minor changes so as to provide the basis for compromise, he reduced the number of officers on the commission to four and, to a limited extent, the commission's powers over nuclear research, stating that its mission would be to minimize interference in private research and to make more use of it.

But these modest changes did not satisfy Bush, who requested that the War Department bill be completely reviewed with the aim of subjecting the commission to the usual government controls except where exemptions were clearly necessary. The bill underwent several revisions in late July and early August, yet it did not fundamentally change in its original approach and continued to prescribe a considerable amount of military control and governmental dominance in nuclear research activities. Consequently, when the War Department submitted its proposals for domestic control of atomic energy to Congress, they largely took the form and direction laid down in the Royall-Marbury bill.[41]

Postwar International Aspects

After the atomic bombing of Japan, the problem of international control of atomic energy loomed large for the leaders of the American and British governments, and each gave the matter their immediate attention.[42] In his 9 August radio message to the American people on the Potsdam Conference, President Truman declared that the United States intended to make the new force of atomic energy into a weapon for peace and that information on weapon design and production would not be released to the rest of the world until adequate means of control had been established. After reading the President's statement, Prime Minister Clement Attlee promptly endorsed it, and on 13 August he publicly stated his support of the "preparation of plans for the future control of the bomb . . . to the end that its production and use may be controlled and that its power may be made an overwhelming influence towards world peace."[43]

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[39] Royall-Marbury draft bill, 18 Jul 45, MDR; Hewlett and Anderson, *New World*, pp. 412–13.

[40] Notes on Interim Committee Mtg, 19 Jul 45, MDR; Ltr, Bush to Harrison, 19 Jul 45, OSRD.

[41] Ltr, Bush to Harrison, 7 Aug 45, OSRD; Interim Committee Log, 20 and 25 Jul 45, MDR; Draft bills, Jun–Sep 45, prepared by MD legal staff for Interim Committee, Admin Files, Gen Corresp, 032.1 (Atomic Legislation), MDR.

[42] Except as otherwise indicated, section based on MDH, Bk. 1, Vol. 4, pp. 7.1–7.17, DASA; Groves, *Now It Can Be Told*, pp. 409–12; Hewlett and Anderson, *New World*, pp. 465–81 and 531–619; Truman, *Memoirs*, 1:523–51 and 2:5–16. Most of the diplomatic documents pertinent to the efforts at international control may be found in the U.S. Department of State, *General: Political and Economic Matters*, Foreign Relations of the United States, Diplomatic Papers, 1945, Vol. 2 (Washington, D.C.: Government Printing Office, 1967), pp. 1–99; ibid., *General: The United Nations*, Foreign Relations of the United States, Diplomatic Papers, 1946, Vol. 1 (Washington, D.C.: Government Printing Office, 1972), pp. 1197–259.

In a memorandum to Truman on 11 September,[44] Secretary Stimson advised the President that the best policy for international control would be for the United States, with British support, to make a direct approach to the Soviet Union, proposing joint arrangements for limiting use of the bomb and encouraging development of atomic power for peaceful and humanitarian purposes. A few days later, at a meeting of the President's Cabinet, Vannevar Bush and Under Secretary of War Patterson joined with Stimson in support of direct negotiations with the Soviets. Other members of the Cabinet, however, opposed sharing the secrets of atomic energy with the Soviet Union and the rest of the world.

The American government, however, was under continuing pressure from the British to institute international control measures as quickly as possible. From the standpoint of the British, who wanted to implement the Hyde Park *aide-memoire* provision assuring them full collaboration "in developing Tube Alloys for military and commercial purposes . . . after the defeat of Japan . . ." and to secure a revision of the 1943 Quebec Agreement provision that restricted their access to information pertinent to the industrial and commercial applications of atomic energy, these international measures were essential not only to ensure that the atomic bomb would be used in the interest of world peace but also to facilitate new agreements on a postwar atomic partnership.[45]

Taking cognizance of the British desire for prompt action, President Truman in his 3 October message to Congress stated emphatically that a discussion on an international control policy could not wait until the United Nations Organization began functioning. Negotiations must begin at once with the United Kingdom and Canada, and then subsequently with other nations, for the purpose of working out "arrangements covering the terms under which international collaboration and exchange of information might safely proceed."[46] Consistent with this objective, Truman at the end of the month accepted Prime Minister Attlee's request for a meeting with him and Canadian Prime Minister William Lyon Mackenzie King.

In preparation for this conference, scheduled to open in Washington on 11 November, both Secretary of State Byrnes and Secretary of War Patterson (who had replaced Stimson on

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[43] Telg, Attlee to Truman, 11 Aug 45, with text of the Prime Minister's statement released on 13 August, reproduced in U.S. Department of State, *General: Political and Economic Matters*, 1945, Vol. 2, p. 40.

[44] The full text of this memorandum is reproduced in Stimson and Bundy, *On Active Service*, pp. 541–46.

[45] *Aide-memoire*, 18 Sep 44, FDR.

[46] Truman, *Memoirs*, 1:530.

27 September) consulted extensively with Bush and Groves. When Bush, on his own initiative, visited Byrnes on 3 November to urge adoption of a definite policy on international control, the Secretary asked him to prepare a written statement of his views of what needed to be discussed by the three heads of state. Sensing a lack of preparation by the State Department for the upcoming conference, Secretary Patterson had members of his War Department staff draw up proposals to be discussed. Both Groves and Bush were called in for consultation by Byrnes on the eighth and by Patterson on the tenth to revise the War Department proposals. When the actual conversations on atomic energy began, Truman and Byrnes advanced the proposals set forth in the statement Bush had prepared for the Secretary of State and the British agreed to them as an agenda without presenting any counterproposals. Byrnes then called in Bush on the twelfth to assist in preparation of the conference communique.

On 15 November, the three political leaders announced their conclusions on atomic energy in the Truman-Attlee-King Declaration. They agreed that an open exchange of the fundamental scientific aspects of atomic energy with other nations of the world was desirable to facilitate its development for peaceful purposes; however, to ensure against its use for destructive purposes, they acknowledged that a limited exchange of the specialized aspects necessary for industrial application must be enforced until such time as the United Nations could establish international controls. To achieve these controls, they recommended that the United Nations set up an international organization to function under its auspices.

The three leaders also directed that steps be taken to work out a new basis for Anglo-American collaboration in atomic energy matters in the postwar period. They delegated the task of preparing a suitable directive to Patterson and Sir John Anderson. Patterson called in Groves and Harrison to advise him, and the two, working with members of Sir John's staff, prepared two memorandums issued on 16 November. The first memorandum stated that there should continue to be full and effective cooperation between the three states in atomic energy matters, that the Combined Policy Committee and Combined Development Trust should be perpetuated,[47] and that the committee should work out an appropriate basis for future collaboration. The second document, "Memorandum of Intention," set forth detailed guidelines for the committee to follow in developing a new agreement to replace the Quebec Agreement.

For the period of several months, the Combined Policy Committee endeavored to work out suitable terms of a new Anglo-American agreement. It turned over to a subcommittee—composed of British embassy staff member Roger Makins, Canadian Ambassador Lester B. Pearson, and General Groves—the task of drafting a report with scientific recommendations for inclusion in a new agreement. When completed, the subcommittee's report called for the rescinding of the provisions in the Quebec Agreement that had restricted British development of atomic energy for industrial and commercial purposes and proposed that each signatory state develop the means for full and effective interchange of information required for its atomic activities; agree not to disclose information or enter into negotiations with outside states concerning atomic energy without prior discussion and policy determination; undertake measures not only to control uranium and thorium deposits within its own borders but also, through established international ore control agencies, to acquire foreign ore deposits; and coordinate and consult with each other before using nuclear weapons against other states. Subcommittee members did not necessarily agree on all points outlined in the submitted report. General Groves, for example, noted that inclusion of many of the suggested provisions, especially those on full and effective interchange, would give the agreement the effect of a secret military treaty in violation of Article 102 of the United Nations Charter.

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[47] The establishment and work of these international advisory groups are discussed in detail in Chs. X and XIII.

On 15 February 1946, the Combined Policy Committee considered the subcommittee's proposals for a new agreement. Committee members were inclined to agree with Groves that many of the recommended provisions would violate Article 102. One member suggested that this conflict with the United Nations Charter be avoided by continuing Anglo-American cooperation on atomic matters under terms of the Quebec Agreement. But Lord Halifax, the British ambassador who had replaced Sir Ronald Campbell on the committee, objected that the wartime agreement did not meet postwar requirements, especially on exchange of information.

At the next committee meeting on 15 April, Halifax shifted his position. The United Kingdom would be willing, he said, to accept the proposal for continued collaboration under the Quebec Agreement and the Declaration of Trust in the area of raw materials, provided that these two documents were amended to meet postwar requirements as outlined in the subcommittee's proposals. This compromise was unacceptable, however, to the American members (Byrnes, Patterson, and Bush) because they did not think it would eliminate the conflict with Article 102. Finding itself in a deadlock, the committee turned the problem back to the heads of state.

Truman and Attlee were unable to make further progress toward the full and effective cooperation they had set as a goal. In fact, Attlee's strongly worded plea to President Truman in June 1946 went unanswered, because Congress was about to enact domestic legislation placing additional restrictions on release of atomic information that cast further doubt on the feasibility of any kind of interchange.

From May until the end of 1946, Anglo-American cooperation on atomic energy continued to function under the Quebec Agreement and the Declaration of Trust. Practically speaking, collaboration was limited essentially to the area of raw materials. In late July, for example, the Combined Policy Committee approved the Groves-Makins-Chadwick formula for allocating in 1946 the larger share of the available supply of uranium ore to the United States so that the Manhattan Project had a sufficient amount to meet the needs of its bomb production program. It also adopted a Combined Development Trust proposal designed to ensure a fair allocation of the costs of raw material received by each country through the Trust since V-J Day.

As the date neared for a civilian agency to take over control of the program in the United States, Attlee wrote to Truman that he felt the time was opportune to resume discussion of cooperation. The President promised to take up the question in the near future, but reminded the Prime Minister that Combined Policy Committee discussions had revealed considerable differences in interpreting the 16 November memorandum by the two countries and that new legislation for domestic control in the United States contained provisions that would further complicate collaboration.

Many factors had contributed to the breakdown of efforts to establish effective Anglo-American cooperation. Among them were the lingering American distrust of the British dating back to wartime incidents, the continuing problem of security (revelations in early 1946, for example, of espionage in the Canadian program that pointed up once again the inherent threat in information interchange), and the determination of the United States not to jeopardize achievement of international control through the United Nations with too close a relationship to the British.

In the efforts of the United States in late 1945 and in 1946 to establish in the United Nations an effective system for the international control of atomic energy, members and former members of the Manhattan Project played a considerable role in assisting the State Department, the agency responsible for developing America's proposals. Foreign ministers of the Soviet Union, the United Kingdom, and the United States met in Moscow from 16 to 20 December 1945 and agreed, as enunciated in the Truman-Attlee-King Declaration of 15 November, to form a United Nations Commission on Atomic Energy, with representatives from each state on the organization's Security Council, and from Canada when it was not a member of the Council. On 24 January 1946, the United Nations General Assembly approved the British resolution authorizing establishment of the Commission on Atomic Energy and scheduled its first meeting in New York City for June. In March, President Truman nominated Bernard M. Baruch, the well-known financier and long-time adviser to American presidents, to be the representative for the United States on the commission.

Meanwhile, the Secretary of State had established a special committee to advise him on the interchange of atomic information with other countries. He named Dean Acheson, the Under Secretary of State, chairman of the committee, and appointed John J. McCloy (who had resigned as Assistant Secretary of War in November 1945 to return to the practice of law), Bush, Conant, and Groves as members. At its first meeting on 14 January, Acheson suggested that, because the members of the committee were busy officials who could devote only a limited amount of time to preparation of such a plan, the committee should appoint a panel of consultants to assemble the pertinent data and draw up proposals. General Groves objected, pointing out that he, Bush, and Conant were familiar with the problems involved.

But the special committee decided in favor of a panel. The six members—David E. Lilienthal of the Tennessee Valley Authority, who served as chairman, Chester I. Barnard of New Jersey Telephone, Harry A. Winne of General Electric, Charles A. Thomas of Monsanto Chemical, and J. Robert Oppenheimer, who had left Los Alamos and returned to the University of California, Berkeley—submitted a draft report to the committee in early March. This draft, after considerable revision, became the basis for the Acheson-Lilienthal report, a plan for step-by-step cooperation of the United States with the other nations of the world in establishing international controls over atomic energy. The report, released on the twenty-eighth, served as a working paper and a basis for public discussion. The United States delegation to the United Nations Commission on Atomic Energy presented the essential points of the plan in June, and these became substantially the principles finally accepted by the commission on 30 December. During the extended deliberations, Bernard Baruch relied heavily upon many members and former members of the Manhattan Project, including Groves, who served as his consultant; Tolman, who acted as his scientific adviser; and a scientific panel made up of Robert F. Bacher, an experimental physicist who had served in various capacities at Los Alamos, Arthur Compton, Oppenheimer, Thomas and Urey.

Postwar Domestic Aspects

"No matter what international policy may be eventually worked out for the United States and the world," General Groves told a congressional committee, peacetime control of atomic energy "is necessary to protect America's tremendous investment in atomic research and development and to insure that this development will go steadily forward."[48] To achieve this end, members of the Manhattan Project in late 1945 and early 1946 actively participated in the planning and ongoing discussions of the various legislative proposals under consideration.

Shortly after V-J Day, the Interim Committee sent the President its revised Royall-Marbury bill on atomic energy, and the President immediately circulated the draft measure to the various government agencies likely to be affected by its provisions so that they could review it. Assured by the commitee's provision that any legislation enacted should be subject to revision at the end of a two-year period, most of the agencies gave their approval to the draft bill very quickly. Only the State Department, which was deeply involved in the question of international control, threatened to hold up its approval for an indefinite period. But because most of the leaders associated with the wartime atomic energy project strongly felt there should be no delay in establishing a clear national policy, Secretary Patterson secured the President's permission to proceed without that agency's approval and to introduce into Congress what came to be known as the May-Johnson bill.[49]

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[48] Quotation from Groves's 28 Nov 45 opening statement in *Atomic Energy Hearings on S. Res. 179*, p. 32, with pertinent paragraphs reproduced in App. X of Groves, *Now It Can Be Told*, pp. 441–42. Except as otherwise indicated, section based on Groves, *Now It Can Be Told*, pp. 389–98; Hewlett and Anderson, *New World*, pp. 482–530; U.S. Congress, Senate, Special Committee on Atomic Energy, *Atomic Energy Act of 1946: Hearings on S. 1717*, 79th Cong., 2d Sess., 22 Jan–8 Apr 46 (Washington, D.C.: Government Printing Office, 1946); and on HB Files, especially Fldrs 6 (S–1 MPC), 15 (Hist of Atomic Bomb, Apr 45), 63 (Working Committee, 1945–46), 65–69 and 72–74 (Interim Committee), 82 (Atomic Energy Bill–1945), 88 (Analyses of Bills), 89 (Amendments, Analyses, etc., of May-Johnson Bill, 1945), and 100 (A–1 Interim Committee–Min of Mtgs), MDR.

On 3 October, the President in his message to Congress emphasized the need for prompt action on the measure to ensure preservation of the enormous investment in atomic energy, to provide direction for continuing research, and to establish adequate controls over raw materials. That same day, Congressman Andrew J. May introduced the War Department's bill. When the hearings on the bill opened in the House Military Affairs Committee on the ninth, Secretary Patterson in a prepared statement explained to the committee why the Army was anxious to turn over responsibility for atomic energy to a peacetime organization: "The War Department has taken the initiative in proposing that it be divested of the great authority that goes with the control of atomic energy, because it recognizes that the problems we face go far beyond the purely military sphere. The atomic bomb is the most devastating weapon we know, but the means of releasing atomic energy which it employs may prove to be the greatest boon to mankind in the world's history. The wisest minds in our Nation will be required to administer this discovery for the benefit of all of us."[50]

Also appearing before the committee were Groves, Bush, and Conant. Committee members questioned each of them concerning the unusually broad powers to be given to the atomic energy commission proposed in the bill. Groves, who first restated the Army's desire to be relieved of the burden of administering the atomic energy program, posited that the powers were necessary for the commission to cope with its vast responsibilities. Bush granted that Congress would be giving up control of atomic energy, except for appropriations and its right to revise the basic act, but considering the enormous hazards, he believed rigid federal control was an absolute necessity. Conant, too, expressed the view that the commission must be able to exercise extraordinary controls for reasons stated clearly in the bill itself: "The misuse of such energy, by design or through ignorance, may inflict incalculable disaster upon the Nation, destroy the general welfare, imperil the national safety, and endanger world peace."[51] At the conclusion of the testimony, the committee prepared to end the hearings and report the atomic energy bill back to the floor of the House.

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[49] The Interim Committee bill, in view of the military potentialities of atomic energy and preparation of the measure under the guidance of the War Department and Manhattan Project, was remanded to the military affairs committees of both Houses. Congressman Andrew J. May, representing a Kentucky district, headed the House Military Affairs Committee and Senator Edwin C. Johnson of Colorado was the ranking member of the Senate Military Affairs Committee.

[50] Quotation from Patterson's 9 Oct 45 opening statement in U.S. Congress, House, Military Affairs Commitee, *Atomic Energy Hearings on H. Res. 4280*, 79th Cong., 1st Sess., 9 and 18 Oct 45 (Washington, D.C.: Government Printing Office, 1945), p. 7.

But adverse reaction in the Senate Military Affairs Committee, and from the press and public, indicated the measure would arouse considerable opposition. When Senator Edwin C. Johnson introduced the bill in the Senate committee, Senator Arthur H. Vandenberg of Michigan, the committee's minority leader, challenged it as dealing with a subject beyond the competence of a standing committee and therefore requiring consideration by a special joint committee of Congress. He had already introduced a joint resolution proposing formation of such a committee. By a parliamentary maneuver, he was able to hold up further consideration of the bill until the House of Representatives voted on his resolution.

Meantime, newly formed associations of atomic scientists at the Metallurgical Laboratory and at the Clinton Engineer Works had mobilized a press campaign against the bill on the grounds that it was an attempt by the Army to railroad legislation through Congress without the extensive hearings before an impartial committee such an important subject deserved. They also gave voice to the suspicion that the bill represented an attempt by the War Department and the Navy to secure control of the postwar atomic energy organization, pointing especially to the provision that would permit military officers to serve in the chief administrative posts without adequate supervision by the part-time commissioners. Many scientists, too, called attention to the severity of the penalties provided in the bill's security provisions (ten years in prison and a $10,000 fine), seeing in them evidence of an attempt to place undue restrictions on scientific employees in the postwar atomic program. Members of the Interim Committee's scientific panel, who had earlier endorsed the May-Johnson bill, expressed alarm at the heavy penalties for unauthorized release of classified information.

These developments marked the beginning of a prolonged legislative battle. During the remainder of 1945, a coalition of scientists, legislators, and government officials exerted a growing opposition to the May-Johnson bill, which had at first the effect of preventing the backers of that measure from securing its rapid enactment and led ultimately to its displacement by a bill more acceptable to the groups in the coalition. Becoming increasingly aware of the growing criticisms of the May-Johnson bill, President Truman privately withdrew his endorsement, leaving the way open for substantial changes in the measure. And in the Senate, support grew for Vandenberg's proposal that a special committee be established to deal with atomic energy matters. When his resolution for setting up a joint committee of both Houses failed to secure the required votes, Brien McMahon, a young senator from Connecticut, led a movement for creation of a special committee in the Senate. Passage of a resolution subsequently established the Special Committee on Atomic Energy, with McMahon as chairman.

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[51] Quotation from Conant's opening statement in ibid., p. 51. Conant was quoting from the May-Johnson bill, Declaration of Policy, Section 1 (a).

Serving with McMahon were Senators Vandenberg, Johnson, Richard B. Russell, Tom Connally, Harry F. Byrd, Millard E. Tydings, Warren R. Austin, Eugene D. Millikin, Bourke B. Hickenlooper, and Thomas C. Hart. Edward U. Condon, the physicist who had worked at Los Alamos briefly during the war but departed because of his objection to security measures, joined the committee as its scientific adviser and James R. Newman, a lawyer with an extensive knowledge of science, as its special counsel. In late November, while Newman worked with Manhattan and other government officials to draft a substitute measure to replace the May-Johnson bill, the committee commenced a series of almost daily public hearings with the objective of informing its members and the American people on the scientific aspects of atomic energy. It closed the hearings on 20 December, when Senator McMahon introduced his new bill, and reconvened them in late January 1946.

As the attention of the country focused on atomic energy, opposition grew toward any legislation likely to give an undue amount of influence to the military in atomic activities and place too restrictive controls on nuclear research and scientists. The movement, an aspect of widespread postwar weariness with things military, received extensive support among scientists employed on the Manhattan Project, who were by then effectively organized as the Federation of Atomic Scientists.

In February, Secretary Patterson and General Groves testified before the Senate Special Committee, urging passage of legislation generally along the lines of the May-Johnson bill. Both objected strongly to the provisions in the McMahon bill that virtually excluded the armed services from participation in the military application of atomic energy. Groves, for example, contended that no shift in emphasis on atomic energy as a military weapon was possible until there were no longer wars between nations. Both also felt that the security provisions of the McMahon bill, based upon the Episonage Act, were inadequate for an area as sensitive as atomic energy.

Secretary Patterson thought the McMahon bill placed too many restrictions on research in nuclear science. Groves continued to express preference for the May-Johnson bill's provision that the members of the commission be part-time, rather than full-time as provided by the McMahon measure, because he believed more capable men could be secured for part-time service. He also objected to the McMahon bill's exclusion of active military members from the commission and he favored the May-Johnson bill's provision of a single executive rather than a commission performing the executive function.[52]

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[52] Patterson's 14 Feb 46 opening statement before the Senate Special Committee on Atomic Energy may be found in *Atomic Energy Act Hearings on S. 1717*, pp. 389–90; the original version of the statement, as prepared by the Secretary's office, is in HB Files, Fldr 92 (Drafts of Secy War Testimony), MDR. Groves's 27 Feb 46 opening statement may be found in *Atomic Energy Act Hearings on S. 1717*, pp. 467–68; the original version of the statement, as prepared by Groves's office, is in OCG Files, Gen Corresp, MP Files, Fldr 13 (Legislation), MDR.

Although the Special Committee had reported the McMahon bill to the Senate on 19 April, it did not come to the floor of the Senate until 1 June. After only three hours of debate and a few minor amendments, the measure passed with no dissenting votes. The bill went to the House Military Affairs Committee on the fifth and, after brief hearings (11–13 June), to the House of Representatives. The House passed the bill with major changes on 20 July, but most of the amendments were removed in a subsequent conference session. President Truman signed the measure on 1 August as the Atomic Energy Act of 1946. Under terms of the act, the Army's responsibility for direction and control of atomic energy in the United States was to pass to a civilian agency, the United States Atomic Energy Commission. This legislation also created the Military Liaison Committee and the General Advisory Committee, which were to provide, respectively, coordination and support on matters relating to future military and scientific and technical applications.[53]

For the wartime leaders of the Manhattan Project, the long-delayed enactment of the Atomic Energy Act marked another significant step in their efforts to solve the problems they faced in peacetime control of atomic energy. Already they had achieved success in the program for release of public information, accomplished without endangering the nation's security. But many were convinced that provisions in the new legislation were likely to be inadequate from the standpoint of security and ineffectual for the future military application of atomic energy. Many also were disappointed in the limited success attained in reaching workable agreements for international control of atomic energy. They had willingly made available their special knowledge to the American, British, and Canadian political leaders endeavoring to achieve such agreements through diplomatic negotiations and the new United Nations Organization. These efforts, however, clearly revealed that substantive progress in international exchange of information and control of atomic energy would become possible only when ways were found to remove the numerous and persistent causes of fundamental distrust among the nations of the world.

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[53] As spelled out in the Atomic Energy Act of 1946 (Public Law 585, 79th Congress), the Atomic Energy Commission was to consist of five civilian presidential appointees who would serve full time administering the program; the General Advisory Committee, nine civilian presidential appointees who would meet at least four times a year; and the Military Liaison Committee, representatives of the War and Navy Departments whom the Secretaries would detail in such numbers as deemed necessary.

CHAPTER XXVIII

The Army and the Atomic Energy Program, 1945–1947

In the months leading up to the end of the war, the Army's involvement in the Manhattan Project had expanded rapidly as all of its efforts converged on completing its atomic mission and saving the lives of thousands of fighting men. With the attainment of the wartime objective, the project's military leaders expected that the Army's administration of the atomic energy program would be promptly terminated and strongly recommended that the government adopt this course of action. In October, while appearing before the House Military Affairs Committee, General Groves once again advanced this point of view, stressing that the Army's "responsibility for directing all activities relating to the release and use of atomic energy . . . should not be continued today." Yet his solution of vesting control "in the most representative and able body our democratic society is capable of organizing" was not immediately possible, and the Army was left with no alternative but to continue in a prolonged and often frustrating caretaker role.[1]

A Postwar Trusteeship

In carrying out what Groves later termed its "trusteeship," the Army not only would contribute significantly to preserving much of the wartime program but also, in spite of widespread opposition to its influence, would have an opportunity to leave its imprint on the character of the peacetime program. "The War Department will always have a vital interest . . . in atomic energy," Groves told the Senate's Special Committee on Atomic Energy, and "in the field of practical administration and operation the Army can furnish invaluable assistance." [2]

While Congress and the country debated the issue of a successor organization during late 1945 and early 1946, the Army experienced a difficult period of transition because of a number of critical operational and administrative problems at Manhattan's production and research facilities. Especially challenging was the serious manpower problem that resulted from the process of postwar demobilization. "Because of the current uncertainty," Groves had warned the Senate committee in November 1945, "we are losing key people whose services should be retained. Until that uncertainty is resolved by the establishment of a national policy, . . . [the project will experience an] appreciable loss of the present efficiency of the vast combination of plants, scientific talent, and engineering skill." [3]

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[1] Quotations from Groves's 9 Oct 45 opening statement in *Atomic Energy Hearings on H. Res. 4280*, p. 9, with pertinent paragraphs reproduced in App. IX of Groves, *Now It Can Be Told*, pp. 440–41. A copy also may be found in HB Files, Fldr 66, MDR.

[2] Quotations from Groves's 28 Nov 45 opening statement in *Atomic Energy Hearings on S. Res. 179*, p. 31, with pertinent paragraphs reproduced in App. X of Groves, *Now It Can Be Told*, pp. 441–42.

Project Operations and Problems

In the weeks immediately after the surrender of Japan, while Manhattan District teams were collecting data on the effects of the Hiroshima and Nagasaki bombings and tracing the progress of Japanese scientists in the field of atomic energy, General Groves and his staff were preparing to convert the atomic program to a peacetime status. As perceived by Groves, the Army's responsibility during the transitional period would be keeping the wartime program functioning efficiently, closing down those elements that were no longer needed, completing construction projects already in progress, and maintaining as far as feasible an effective working organization in face of the eroding pressures of demobilization.

To facilitate the Army's interim stewardship of the atomic program, Groves and his staff drafted a plan for postwar project operations.[4] Under this plan, fissionable materials production at the Clinton and Hanford Engineer Works would be reduced by about 15 percent, thus cutting operating costs more than 30 percent and achieving an appreciable savings in uranium; weapons production at the Los Alamos Laboratory would continue, but at a somewhat lower rate, with the objective of building a stockpile of twenty bombs. Project operations, Groves emphasized, would proceed at this curtailed rate only until Congress reached a decision on America's future atomic energy policy. In late August, following the Military Policy Committee's approval of his plan, the Manhattan commander submitted it to the Secretary of War and the Chief of Staff for their endorsement. After a close review, Stimson and Marshall concurred with the provisions of the plan.

An obvious first step to implementing Groves's plan was to close down less efficient production units, to achieve the most economical use of money, manpower, and materials. In early September, the District shut down the thermal diffusion plant at Clinton and placed the Alpha racetracks of the electromagnetic plant on standby. Additional Beta facilities under construction would be ready in November to provide much more efficient enrichment facilities than the unreliable Alpha calutrons. Furthermore, upper stages of the gaseous

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[3] Quotation from *Atomic Energy Hearings on S. Res. 179*, p. 32. See also Statement by General Groves on Dissolution of Manhattan Engr Dist, 14 Aug 47, Admin Files, Gen Corresp, 319.2 (Misc), MDR.

[4] For details of Groves's plan see Memo, Groves to Chief of Staff, 23 Aug 45, OCG Files, Gen Corresp, MP Files, Fldr 2, Tab A, MDR. Groves appears to have based his plan on Draft Memo, Groves (prepared by Nichols) to Secy War, 13 Aug 45, OCG Files, Gen Corresp, Groves Files, Fldr 17, Tab K, MDR.

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diffusion plant, which had proved to be the most efficient producer of partly processed uranium feed, had become operational in mid-August, making available higher assay feed for the Beta enrichment process. The District also decided to complete construction of the plant's K-27 side-feed extension unit, scheduled to be ready for full operation by early 1946.

At Hanford, the District directed Du Pont to continue operation of all three production piles but to shut down one of the two chemical separation plants. It also closed the last of the three heavy water plants that the project had built in the United States; two had ceased operation before V-J Day. The plant at Trail (British Columbia) continued in operation, but the District recommended that by January 1946 partial control be turned over to the Canadian firm (Consolidated Mining and Smelting Company) operating it.

In contrast to Clinton and Hanford, the future of postwar operations at Los Alamos was more problematic because of the combination of production activities with an extensive research and development program. Under Groves's plan, bomb production at Los Alamos was to continue at least until completion of an adequate stockpile of weapons. But the laboratory was no longer the base of operations for bomb production. Soon after the end of the war, the engineering group of the laboratory's ordnance division had decided to consolidate much of its weapon assembly activities at Sandia Base, located directly east of Kirtland Field on the site of Albuquerque's original airport at the southern edge of the city. Beginning in September 1945, to support bomb production activities at Sandia, essential technical and military personnel from Los Alamos and all project personnel and facilities from Wendover Field transferred to the Albuquerque site. Finally, in early 1946, most of the remaining members of the engineering group relocated there.[5]

Another problem in Los Alamos operations was the progressive erosion of its scientific and technical personnel. Because of the uncertainty of the laboratory's future, many wartime scientists and technicians prepared to resign and return to civilian pursuits. Some, of course, would have departed under any circumstances; the war was over and they had jobs waiting in universities, scientific laboratories, or industry. Others were tired of the security restrictions or disliked the isolation and unfavorable living conditions.

To deal with this personnel problem, General Groves and Oppenheimer, who was himself returning to the University of California at Berkeley, met with the scientists and technicians in the weeks following the end of the war. During these meetings the two leaders assured the staff members that the laboratory would continue to be a center of weapons research, that security would be less strict, and that the work schedule would be more relaxed. Even the newly appointed interim laboratory director, Comdr. Norris Bradbury, joined in the efforts to arrest the outflow of personnel. At a briefing in October, he outlined a program of the activities he hoped would be sufficiently attractive to hold some of the scientific staff—reengineering implosion weapons, research on the feasibility of the hydrogen bomb, further Trinity-type tests, and study of constructive uses of atomic energy. But despite these efforts, the laboratory by early 1946 was seriously short of both scientific and technical personnel.[6]

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[5] The immediate postwar history of the bomb production groups at Los Alamos and Sandia Base is covered in some detail in Frederic C. Alexander, Jr., *History of Sandia Corporation Through Fiscal Year 1963* (Albuquerque, N.Mex.: [Sandia Corp.], 1963, pp. 1-14. See also MDH, Bk. 8, Vol. 2, "Technical," Supp., pp. VIII.1-VIII.7, DASA. In the transition period from July 1945 to July 1947, the total number of nuclear components for bombs produced was about eighteen (seventeen implosion, one gun), which included those for the test device exploded at Trinity, the two bombs used on Hiroshima and Nagasaki, and the two exploded in Operation CROSSROADS. An estimated twenty-nine mechanical assemblies for implosion bombs were available in June 1947. See David Rosenberg, "U.S. Nuclear Stockpile, 1945 to 1950," *Bulletin of the Atomic Scientists* 38 (May 82): 25-30. The above figures are derived from Table, p. 26.

OPPENHEIMER CONGRATULATING THE TROOPS. *In one of his last official acts, the laboratory director participated with Col. Gerald R. Tyler, post commander, in an awards ceremony at Los Alamos.*

Manhattan's other research and development centers experienced difficulties similar to those at Los Alamos. Sensing that a time of uncertainty would follow employment of the bomb, project scientists had long been proposing possible areas for continued research and development in the field of atomic energy. They suggested, for example, exploring atomic energy as a source of power for both military and civilian applications, producing radioactive isotopes for scientific research and industrial uses, and improving devices to employ the tremendous explosive energy of fission. But the Army hesitated to start any research program that would constitute long-range commitments for the still to be established successor agency to the Manhattan Project.[7]

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[6] This account of developments at Los Alamos from August to December 1945 is based on Hewlett and Anderson, *New World*, pp. 625–27; Groves, *Now It Can Be Told*, pp. 377–79; MDH, Bk. 8, Vol. 2, Supp., passim, DASA. Commander Bradbury, a physicist, served for four years at the Naval Proving Ground (Dahlgren, Virginia) before coming to Los Alamos in 1944 to head the field test program for the implosion bomb. He subsequently worked on a variety of other programs at the laboratory. On the interim director's efforts see Ltr, Bradbury to Groves, 3 Nov 45, 322 (Los Alamos); Ltr, Bradbury to Lt Col Stanley L. Stewart (Los Angeles), 14 Nov 45, 600.12 (Los Alamos); Ltr, Bradbury to Groves, 23 Nov 45, 600.12 (Projs and Prgms). All in Admin Files, Gen Corresp, MDR. For Groves's views on replacing Oppenheimer see Draft Memo for Record, Groves, 13 Sep 45, Admin Files, Gen Corresp, 001, MDR. On the departure of the British scientists from Los Alamos see Ltr, Chadwick to Groves, 9 Jan 46, Admin Files, Gen Corresp, 201 (Chadwick, J.), MDR.

[7] On proposed postwar programs in atomic energy see committee reports of meetings at the Metallurgical Laboratory in the fall of 1944, which may be found in Admin Files, Gen Corresp, 334 (Postwar Policy-CEW), MDR. See also Rpt, Scientif-

Continued

Although most of the project's research and development facilities had to devote their time to the generally less attractive and challenging business of winding up wartime research, some managed to launch their own investigations into aspects of atomic energy that held broader promise for the future. At the Clinton Laboratories, scientists continued wartime investigations into the effects of radiation on animals and undertook recovery of uranium from wastes held in storage solutions, but also began two new programs: the production of radioactive isotopes, and the design and development of a heterogeneous pile using enriched uranium. At the Metallurgical Laboratory, while operating under an interim organization, scientists kept busy supporting the Hanford project, but also were able to give some time to such programs as the development of a breeder reactor for producing nuclear fuel.[8]

Of all the project's research and development centers, the Radiation Laboratory succeeded best in switching from wartime activities to fundamental scientific research. It had been a well-established research center before the war (since 1935) and could again take up suspended tasks (such as completing the 184-inch cyclotron, stopped in 1941) and new projects (such as building a synchroton, an apparatus for imparting charged particles with higher speeds than were possible in the cyclotron). Ernest Lawrence, continuing as director of the laboratory, even managed to persuade a reluctant General Groves to approve use of some government funds to carry on these scientific construction projects.[9]

As the Army was curtailing project operations and winding up its research and development programs, the process of postwar demobilization became a serious threat to its effective administration of the program during the interim period. In an effort to maintain present efficiency, the district engineer in October 1945 requested all organizations in the project to make a study of their anticipated personnel problems and to submit plans for making the necessary adjustments. In the next eight or nine months, he noted, many military personnel would become eligible for release. Some in this category could continue in a civilian capacity in their present assignments, while others

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ic Panel, sub: Proposals for R & D in the Field of Atomic Energy, 2 vols., 28 Sep 45, HB Files, Fldr 113, MDR; Ltr, Compton to Secy Comm Henry A. Wallace, sub: Policy Re A-Energy, 27 Sep 45, Admin Files, Gen Corresp, 312.1 (A-Energy), and Ltr, Bradbury to Groves, 23 Nov 45, Admin Files, Gen Corresp, 600.12 (Projs and Prgms), MDR. On the production and release of radioactive isotopes for scientific research see the materials in Admin Files, Gen Corresp, 441.2 (Isotopes), MDR.

[8] The term *breeder reactor* was broadly applied to any nuclear chain reactor in which fertile material (U-238, for example) could be converted into more fissionable material than it consumed. Looking to the future use of atomic energy as a source of power for producing electricity and propelling naval vessels, nuclear scientists could perceive the value of developing a means for steadily increasing the stockpile of fissionable material. The breeder would maximize utilization of fertile, nonfissionable material by converting it into nuclear fuel that could be used for the production of power. For a detailed explanation of the breeder reactor see Glasstone, *Sourcebook on Atomic Energy*, pp. 572–74, pars., 15.44–15.52.

[9] This paragraph and the preceding one based on Hewlett and Anderson, *New World*, pp. 627–28. The Metallurgical Laboratory operated under an interim organization because Arthur Compton had left to become chancellor of Washington University in St. Louis, Missouri.

would become available for reassignment to other installations. Planning well in advance of these inevitably disrupting shifts of personnel, the district engineer advised, was the only way to prevent a serious decline in the efficiency of project operations.[10]

Personnel attrition was especially heavy among Manhattan's commissioned officers. During the war, the military officer complement was comprised almost exclusively of noncareer reservists; at the war's end, most were eligible for immediate discharge. For replacements, Groves decided he would need about fifty regular officers. Under ordinary circumstances, a request for this number could readily be filled, but the Manhattan commander advanced special requirements that complicated the requisition. He specifically stipulated that only the most highly qualified officers meeting very strict selection standards be assigned to Manhattan as replacements, for officers of lesser capabilities could not work successfully with scientists and would not be able to acquire the technical knowledge needed to perform effectively on the project.

The replacements were needed quickly, and because there was little time for extensive investigation into their qualifications, Groves turned to graduates of the United States Military Academy as the most likely source of candidates. This policy soon brought protests from the War Department General Staff, which could see no reason why the Manhattan Project should have first choice of the best-qualified officers in the Army. General Groves sought the support of the new Chief of Staff, General Eisenhower, for this selection policy, but the latter sided with the General Staff. Groves then turned to Secretary of War Patterson, who finally resolved the matter in his favor. The Manhattan commander, Patterson directed, was "to have as many officers as he decided he needs and of the quality he thinks he needs, and I want him to have complete freedom of choice."[11]

During the Army's postwar stewardship, the number of commissioned officers fell from a September 1945 peak of more than 700 to a December 1946 low of 250. But the decline was generally proportionate to the overall reduction in employment on the project during the transition period (thus, contractor employment fell from eighty thousand to a little over forty thousand in the same months). Similarly, enlisted personnel declined from over five thousand to somewhat more than two thousand. While there was the anticipated turnover in officer personnel characteristic of any period of demobilization after a war, a surprisingly large percentage of the wartime officers in key positions stayed on until at least the latter part of 1946, and many of those who did

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[10] MD Cir Ltr, sub: Org Adjustments, 27 Oct 45, Admin Files, MD Directives, Ser. 46, Control, MDR.

[11] As quoted in Groves, *Now It Can Be Told*, p. 376. A good example of the quality of regular officers Groves was able to secure was Col. Frederick J. Clarke, an engineer officer, who, in early 1946, replaced Colonel Matthias as area engineer at Hanford. Clarke, a graduate of the United States Military Academy, held important assignments in the Army Service Forces during the war, and before completing his career in the Army, he served as the engineer commissioner for the District of Columbia (1960–63) and as the Engineers chief (1969–73). See Corps of Engineers, ***Engineer Memoirs: Interviews With Lieutenant General Frederick J. Clarke*** (Washington, D.C.: OCE Historical Division, 1979), pp. v and 93–106.

SECRETARY OF WAR ROBERT P. PATTERSON *(left) meeting with General Groves on postwar problems*

resign continued with the atomic project in a civilian capacity.[12]

Serious losses of personnel also occurred among operational and research employees, including most of the nonmilitary scientists and technicians. From a total of ten thousand in September 1945, this group declined to under three thousand by December 1946. Other contract employees—chiefly those operating the production facilities and maintaining services at Clinton and Hanford—also fell in numbers, but at a somewhat slower rate. In the same period, the decline at Clinton was from about forty-five thousand to twenty-five thousand and at Hanford from ten thousand to less than five thousand. At the New Mexico site, the always small operating work force remained at a constant level of fifteen hundred to two thousand during late 1945 and most of 1946, then rose rapidly in November and December to over five thousand as the Sandia Base built up its personnel.[13]

Destruction of Japanese Cyclotrons

Illustrative of the serious breakdown in the operating efficiency of the Army in the first hectic months of its postwar trusteeship was the unfortunate decision to destroy the Japanese cyclotrons.[14] With the war over, the process of demobilization began to diminish the ranks of the project's key personnel. Despite concerted efforts to procure only highly competent men, the experienced were replaced in some instances by the inexperienced. This was the case at Groves's personal headquarters in Washington, where the staff officer who prepared the directive to destroy the cyclotrons was, in Groves's opinion, not sufficiently familiar with the project's operating procedures.

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[12] MDH, Bk. 1, Vol. 8, "Personnel," Apps. A1 (Chart, Manhattan Proj Contractor Employment, Aug 42–Dec 46) and A13 (Chart, MD Mil Personnel, Aug 42–Dec 46), DASA; Org Charts, U.S. Engrs Office, MD, 10 Nov 44 and 6 Nov 46, Admin Files, Gen Corresp, 020 (MED–Org), MDR.

[13] MDH, Bk. 1, Vol. 8, App. A1, DASA.

Manhattan's discovery of the Japanese cyclotrons in the weeks immediately following the Hiroshima and Nagasaki bombings was significant, for it confirmed the wartime judgment of project scientists that, in the area of atomic energy, Japan had not progressed beyond the stage of laboratory research. The country had too few scientists trained in nuclear physics and lacked both the sources of uranium and the necessary industrial capacity to produce fissionable materials for development of atomic weapons.

A project survey team had found cyclotrons at three of the major scientific research institutions in Japan: two at the Institute for Physical and Chemical Research in Tokyo, two at the Osaka Imperial University, and one at the Kyoto Imperial University. After Japan's surrender, scientists at these institutions requested permission from the headquarters of General MacArthur, recently appointed Supreme Commander for the Allied Powers (SCAP), Japan, to resume operations of these cyclotrons for various research projects. SCAP authorities promptly granted a permit for operation of those at the Institute for Physical and Chemical Research, although they subsequently limited their employment to investigations in biology and medicine.

Meantime, in early September, the War Department General Staff had issued instructions directing destruction of all enemy war equipment, except that which was to be saved for examination because of its new or unique character. The instructions clearly stated that "equipment not essentially or exclusively for war which is suitable for peacetime civilian uses should be retained." [15] On 30 October, the Joint Chiefs of Staff expanded these instructions, directing commanders in the Pacific area and China to seize any facilities for research in atomic energy and related fields and to take into custody any individuals engaged in nuclear research.

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[14] This account of the destruction of the Japanese cyclotrons is based on the following sources: Correspondence and related items in HB Files, Fldrs 7 and 70, MDR; Correspondence, including MacArthur's denial of responsibility for destruction of the cyclotrons and Secretary of War Patterson's acceptance of that responsibility, in Admin Files, Gen Corresp, 413.6 (Destruction of Japanese Cyclotrons), MDR; Ltrs, Dean Acheson (for Secy State) to Sir Frederic W. Eggleston (Australian Minister to U.S.), 10 Dec 45, and Col R. L. Vittrup (for Secy War) to State Dept, Attn: Japan-Korea Economic Division, sub: Request for Info on Cyclotrons in Japan, 29 Dec 45, in U.S. Department of State, *The British Commonwealth [and] The Far East*, Foreign Relations of the United States, Diplomatic Papers, 1945, Vol. 6 (Washington, D.C.: Government Printing Office, 1969), pp. 1011 and 1014–15; MDH, Bk. 1, Vol. 14, "Intelligence & Security," pp. 5.1–5.4; Groves, *Now It Can Be Told*, pp. 187 and 367–72; Douglas MacArthur, *Reminiscences* (New York: McGraw-Hill Book Co., 1964), pp. 286–87; Compton, *Atomic Quest*, p. 24; Yoshio Nishina, "A Japanese Scientist Describes the Destruction of His Cyclotrons," *Bulletin of the Atomic Scientists* 3 (Jun 47): 145 and 167.

[15] As quoted in Groves, *Now It Can Be Told*, p. 368.

When a copy of the 30 October directive reached General Groves, he called in an officer from his headquarters staff and went over its contents with him, with the objective of making certain that the five Japanese cyclotrons were brought under control. The Manhattan commander did not specify precisely how they were to be secured. The staff officer, interpreting his instructions from Groves to be that he was to take steps to have the cyclotrons destroyed, on 7 November prepared a message to General MacArthur ordering that this be done as soon as they were no longer needed by Allied scientific teams to obtain technical and experimental data. Because the message was to go out under the Secretary of War's name, Groves's office cleared it through John W. Martyn, Patterson's administrative assistant, who, viewing it as concerned only with a routine matter, did not specifically call it to the Secretary's attention.[16]

On 24 November, SCAP headquarters reported to the Joint Chiefs of Staff that it had started destruction of the cyclotrons, which it had seized on the twentieth, citing as authority only the 30 October directive. Although copies of the report went to the offices of nine different officials, including that of General Groves, apparently no one in authority actually saw it. In retrospect, Groves attributed the failure of policymaking officers in Washington to question the destruction on the widespread inexperience prevalent in subordinate staffs as a result of the postwar readjustment.[17]

SCAP headquarters first got an inkling that there was some confusion in policy within the War Department on the matter of the Japanese cyclotrons when it received a request on 28 November to send one of the cyclotrons to the United States for study. General MacArthur personally informed General Eisenhower of the conflicting instructions, but received no reply to his cable.

Meanwhile, the story of the destruction of the cyclotrons had come out in the American press. A dispatch from Tokyo carrying a date line of 24 November attributed the action to orders from General MacArthur. However, another story on 29 November, quoting sources in MacArthur's headquarters, stated that the decision was not made by SCAP, but by a "higher authority" in Washington. The occupation government had reluctantly carried out these instructions.[18]

Faced with inquiries from the press, the War Department cabled MacArthur's headquarters that it had never sent the instructions to destroy the cyclotrons. The department conceded, however, that its failure to comment on MacArthur's message of

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[16] General Groves notes in his memoirs (see ibid., p. 369) that the staff officer who oversaw preparation of the message had only recently been assigned to the atomic project. He thinks that if the officer had been more familiar with the project's operating procedures, he would have questioned Groves's apparent desire to have the cyclotrons destroyed. The destruction order thus would have been brought to Groves's personal attention, and he would have had it remanded. The draft cable message is attached to Memo, Maj Amos E. Britt (for Groves) to Martyn, sub: Destruction of Cyclotrons in Japan, 7 Nov 45, HB Files, Fldr 7, MDR.

[17] Groves, *Now It Can Be Told*, p. 369.

[18] *New York Times*, 24 and 29 Nov 45.

24 November had contributed to the misunderstanding. MacArthur replied that the special instructions had come from the Secretary of War, pointing out that he had personally informed Eisenhower of their apparently conflicting nature but had never received a reply. MacArthur felt he had to answer the untrue charges, which continued to appear in the press, that the occupation government had made the decision to destroy the cyclotrons. The War Department immediately sent him assurances that he had acted correctly and the misunderstanding had occurred entirely because officials in Washington had not coordinated outgoing messages.

Having thus accepted full responsibility for mismangement of the matter, the War Department had next to seek some way to allay the continuing widespread criticism in the press. Patterson and Groves finally agreed upon release of a frankly worded statement to the press, signed by the Secretary, accepting full responsibility for the unfortunate incident:

> General MacArthur was directed to destroy the Japanese cyclotrons in a radio message sent to him in my name. The message was dispatched without my having seen it and without its having been given the thorough consideration which the subject deserved. Among other things, the opinion of our scientific advisers should have been obtained before a decision was arrived at.
>
> While the officer who originated it felt that the action was in accord with our established policy of destroying Japan's war potential, the dispatch of such a message without first investigating the matter fully was a mistake. I regret this hasty action on the part of the War Department.[19]

The press, apparently not expecting such an open admission of error on the part of the War Department, soon lost interest in the matter of the Japanese cyclotrons. Unfortunately, however, the incident would provide additional fuel for the more vociferous critics of the department's atomic policies in the immediate postwar period.

Reorganization and New Commitments

Faced with a continuing attrition in personnel, the need to prepare programs for fiscal year (FY) 1947, and other urgent administrative problems, the Army decided in early 1946 to abandon the "hold-the line" policy and make long-range commitments necessary to keep the project a viable and efficient operation. For example, Groves advised Bradbury at Los Alamos that "it has . . . become necessary for me to make definite plans, despite the fact that this will commit to some extent at least any future control body." Similarly, in a prepared brief for Groves, General Nichols warned that the Manhattan Project must begin making some firm commitments to avoid dissolution of its many research programs. Hence, a first order of business under the new policy was to make certain changes in the administrative organization of the project, to facilitate planning and to oversee the day-to-day operations.[20]

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[19] WD Press Release, 15 Dec 45, HB Files, Fldr 7, MDR.

[20] Quotations from Ltr, Groves to Bradbury, 4 Jan 46, Admin Files, Gen Corresp, 600.12 (Atomic), MDR. Memo, Nichols to Groves, 2 Feb 46, OCG Files, Gen Corresp, MP Files, Fldr 20, Tab U, MDR. Nichols's promotion to the temporary rank of brigadier general became effective on 22 Jan 46 but was terminated on 30 Jun 46.

The hold-the-line policy had occasioned very few changes in the internal administrative organization of the postwar Manhattan Project up until 1946. The relationship, too, with the War Department had continued more or less on the same basis as during the war, with Groves having a good deal of autonomy in his administration and having access to the department through the Chief of Staff and, when necessary, to the Secretary of War himself. The War Department, in consultation with Groves and Bush, had replaced the Military Policy Committee with a Military Advisory Board, comprised of three Army and three Navy officers responsible for coordinating activities of the War and Navy Departments with those of the Manhattan District. At the same time, the War Department had established an *ad hoc* reviewing committee to indoctrinate selected officers in the organization and work of the Manhattan Project and to submit recommendations for development of appropriate relationships between the project and the War Department. Groves served as a member of this last-named committee, which had met a number of times in late 1945.[21]

The wartime *ad hoc* reviewing committees and the Military Policy Committee had provided invaluable planning assistance to Manhattan, but project leaders soon realized that the new Military Advisory Board, with only military members, was hardly suitable for the task of preparing a viable atomic program for FY 1947.

To correct this deficiency, General Nichols in late January secured Groves's approval for establishment of an Advisory Committee on Research and Development. He enlisted the aid of Richard Tolman and Ernest Lawrence, who soon formed a group consisting of Robert F. Bacher, Arthur H. Compton, Warren K. Lewis, John R. Ruhoff, Charles A. Thomas, John A. Wheeler, and Tolman himself.[22]

The new committee met for the first time in early March at the Manhattan Project office in Washington, joined by General Nichols and representatives of organizations wanting to secure sponsorship of programs. The committee proffered various research and development proposals, noting especially the need for expanding the number of agencies performing research in atomic energy. It recommended continued subsidization of the University of California program and emphasized that university laboratories should devote their efforts primarily to unclassified research but, where necessary, should also carry out classified research, with the basic objective of adding to scientific knowledge. For fundamental research requiring equipment too costly to be purchased by most university or private laboratories, the committee favored the establishment of national laboratories. Finally, it supported the development of high-temperature and fast-fission piles, as well as other reactor projects related to commercial aspects of atomic energy, at government-operated facilities, such as the Clinton Engineer Works and Argonne and Metallurgical laboratories.[23]

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[21] Memo, Brig Gen William A. Borden (New Developments Div Dir, WDSS) to Gen Thomas T. Handy (Dep Chief of Staff), sub: Integration of WD Requirements With Manhattan Proj Opns, 4 Oct 45; Memo, Borden to Chief of Staff, same subject, 12 Oct 45; Memo, Brig Gen H. J. Hodes (Asst Dep Chief of Staff, GSC) to Lt Gen J. E. Hull (Asst Chief of Staff, OPD, WDGS) et al., sub: *Ad Hoc* Committee, 20 Oct 45. All in Admin Files, Gen Corresp, 334 (Committees and Mil Advisory Board), MDR.

[22] Memo, Nichols to Groves, 22 Jan 46, Admin Files, Gen Corresp, 334 (Advisory Committee on R & D), MDR; Hewlett and Anderson, *New World*, p. 633.

The Manhattan District's strong endorsement of the committee's recommendations is evident from the considerable amount of funding allotted for research and development in the FY 1947 budget. The committee had proposed expenditures from $20 to $40 million, but the District's budget provided more than $72 million, divided between construction (68 percent) and operating expenses (32 percent). While the largest amounts went to the project's laboratories at Argonne and Clinton, substantial funds were earmarked for programs at a number of universities. In July 1946, Congress voted the necessary funds to finance the research and development budget.[24]

Of the various proposals, Groves devoted his greatest effort to establishment of the national laboratories. The committee had suggested one laboratory in each major region of the country. Universities and other research organizations in the region would provide a board of directors to recommend research projects and prepare the annual budget. The committee proposed that the first of these laboratories should be the Argonne Laboratory at Chicago and another located somewhere in the northeast.

The University of Chicago in mid-April 1946 agreed to operate the soon to be established Argonne National Laboratory (1 July), which would be formed from the existing Metallurgical and Argonne laboratories, and representatives of twenty-four participating institutions in June submitted data pertinent to the policy to be followed in its organization and operation. The Manhattan District then announced that it would negotiate a formal contract with the University of Chicago. While the participating institutions secured security clearances for their scientists, what was left of the Metallurgical Project staff at Argonne initiated the research program for the new laboratory. Much of this program, of necessity, consisted of continuing projects already in progress at the old Argonne Laboratory, including design of a breeder reactor and investigation of graphite expansion in the piles at Hanford.[25]

In July 1946, nine universities in the northeastern part of the United States—Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Pennsylvania, Princeton, Rochester, and Yale—banded together as the Associated Universities, Inc., to support a national laboratory in that region. Groves announced that this laboratory would be located at the site of the Army's Camp Upton on Long Island, but disagreement among the universities as to the extent that the government should control research activities at the new institution, designated the Brookhaven National Laboratory, delayed a start in its program until early 1947.[26]

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[23] General Nichols reported to General Groves on what the Advisory Committee had proposed in Memo, Nichols to Groves, 14 Mar 46, Admin Files, Gen Corresp, 334 (Advisory Committee on R & D), MDR.

[24] Hewlett and Anderson, *New World*, p. 635.

[25] For a detailed account of the establishment of the Argonne National Laboratory see MDH, Bk. I, Vol. 4, "Auxiliary Activities," pp. 2.5–2.20, DASA. For correspondence and other documents pertinent to its organization see Admin Files, Gen Corresp, 080 (Argonne–Univ of Chicago) and 600.913 (Rpts–Fire and Accidents), MDR.

The committee also had recommended national laboratories elsewhere in the country, especially on the West Coast. But the heads of a group of universities in southern California did not take affirmative action on information forwarded to them by the District in November until the end of the year. Their proposal therefore became a matter for later decision by the new Atomic Energy Commission.[27]

A national laboratory in the southeastern region was unnecessary, because an organization had evolved at Clinton that, by early 1946, was serving a purpose similar to that of the other national laboratories. The Monsanto Chemical Company, the prime contractor for the Clinton Laboratories, had invited the University of Tennessee at Knoxville to conduct graduate courses for its employees as a means of securing and holding the technically trained personnel it needed for its operations. Expanding upon this plan, the University of Tennessee convened a meeting of representatives of other southeastern universities. Out of this conference came an agreement that personnel from these institutions could participate in the graduate training at Clinton and, in addition, make use of the research facilities there. During 1946, District officials and representatives of the various universities involved took steps to formalize the relationship. In October, the associated institutions received a charter from the state of Tennessee as the Oak Ridge Institute of Nuclear Studies, and in the last months of the year, they were proceeding with negotiations for a contract with the Manhattan District.[28]

In addition to providing for the continuation and expansion of the project's research and development programs, Groves and his staff had to keep production operations functioning smoothly and efficiently. From an administrative standpoint, one of the first postwar problems they had to deal with was extending major operating contracts. Most of these contracts had been scheduled to terminate six months after the cessation of actual hostilities, but shortly thereafter Manhattan had secured supplemental agreements to fix the expiration date as 30 June 1946, with options for government renewal for one year. In March, Groves obtained approval from the Secretary of War to exercise these options and to negotiate the necessary contract extensions to 30 June 1947. He informed the Secretary that funds for this purpose were already available, but that additional appropriations would be necessary to prevent a cessation of production and research operations at some time before mid-1947. He also notified the Secretary that one major contractor, the Du Pont Company, had indicated an unwillingness to continue and would have to be replaced.[29]

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[26] MDH, Bk. 1, Vol. 4, pp. 2.20-2.38, DASA.

[27] Memo, Nichols to Groves, 14 Mar 46, MDR; MDH, Bk. 1, Vol. 4, pp. 2.38-2.39, DASA.

[28] MDH, Bk. 1, Vol. 4, pp. 10.1-10.12, DASA.

[29] Memo, Groves to Secy War, 11 Mar 46, Admin Files, Gen Corresp, 008 (WD), MDR.

Subsequent efforts by Patterson and Groves to persuade Du Pont to continue at the Hanford Engineer Works failed. Groves then negotiated a contract with the General Electric Company, similar in most respects to Du Pont's. The major exception was General Electric's insistence that a provision be placed in the contract that would permit the company to be relieved of its obligation in the event that the atomic energy legislation enacted by Congress imposed conditions not acceptable to the firm. The new contract provided for the operation of Hanford, construction of certain new facilities there, and for construction and operation of a government-owned laboratory at the Knolls, some five miles distant from the company's home plant at Schenectady, New York. This laboratory, which was separate from the new Brookhaven National Laboratory, would provide the company with facilities for pursuing its interest in the development of atomic power.[30]

The Hanford production facilities turned over to General Electric had major operational problems. The most serious was the expansion of the graphite moderators in the three production piles, the result of heavy neutron bombardment (the so-called Wigner Effect). Du Pont's plant manager had called this phenomenon to the attention of the district engineer in February 1946, pointing out that there was visible bowing of the tubes containing the uranium slugs and predicting that, because no effective way had been discovered to combat this development, the operating life of the piles certainly was limited. Groves and Nichols had followed Du Pont's suggestion to shut down one pile to ensure that, should the other two become inoperative, one would be available to maintain the essential production of polonium (used as a neutron source in atomic bombs), which could not be stored because of its short half-life. When General Electric took over, two piles were in operation and the oldest unit, the B Pile, was on standby.[31]

Deficiencies in the Hanford separation process were not as serious as those in the pile operation, and Du Pont, with assistance from the Metallurgical Project scientists, had made more progress in finding a solution for them. The drawback of the bismuth phosphate method was that, after extraction of the plutonium, it left the residue of uranium in a state from which it could not be readily recovered. Consequently, much valuable uranium suspended in the process solution was drained off to be stored unused in huge underground tanks. Chemists at the Metallurgical Laboratory had developed another separation process that promised not only to be a more efficient method of removing the plutonium from the process solution but also to leave the fission products and uranium in more easily recoverable states. In August 1946, after engineering and cost studies had demonstrated the feasibility of

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[30] Ltr, C. E. Wilson (Gen Electric president) to Groves, 28 May 46; Memo, Groves to Secy War, sub: Change of Opn and Management Contractor at HEW, 31 May 46; Ltr, Nichols to Lilienthal, 4 Nov 46. All in Admin Files, Gen Corresp, 161 (Electric), MDR.

[31] Ltr, R. M. Evans (HEW Opns Mgr, Du Pont) to Nichols, 20 Feb 46, Admin Files, Gen Coresp, 410.2 (Metals), MDR; MDH, Bk. 4, Vol. 6, "Operations," pp. 4.19–4.20, DASA.

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this process, Du Pont had begun development of a demonstration unit and pilot plant, with the goal of eventually testing the process in a semiworks.[32]

The K-25 and K-27 production units at Clinton were operating more successfully than anyone had anticipated. Plant engineers therefore concluded that the two diffusion units by themselves might achieve as high a concentration of U-235 as the Beta tracks of the electromagnetic plant. In May 1946, the Carbide and Carbon Chemicals Corporation made careful studies to ensure that there was no danger of the concentration level reaching a critical mass in the diffusion plant and that the corrosive effects of the feed material, uranium hexaflouride, were not soon going to destroy the operating surfaces of the process equipment. The Manhattan District then authorized Carbide and Carbon to raise product concentration on an experimental basis, with the objective of obtaining performance data that could be used to justify ultimately shutting down the relatively inefficient and hard-to-maintain Beta tracks of the electromagnetic process.[33]

By way of contrast to Clinton and Hanford, where none of the operating problems seriously interfered with continued production of fissionable materials, deteriorating conditions at Los Alamos during 1946 threatened to halt the continued stockpiling of atomic weapons.[34] Poor morale was a major factor, caused by an uncertain future for the laboratory, a lack of even the basic amenities of a peacetime community, and an intolerance of the military and security aspects of community life.

Groves, determined to improve morale, directed that such measures as were necessary to keep Los Alamos active to meet the defense requirements of the country were to be taken as quickly as possible. "The transition from war to peacetime community conditions will start immediately," he told Bradbury. He outlined a program for community development that became the blueprint for major improvements in the utilities, including a million-gallon steel storage tank to ensure an adequate supply of water at all times; for constructing three hundred permanent housing units; and for increasing recreational facilities to make life at the isolated site less irksome.[35]

While the community development program was being implemented, General Nichols worked on another program to improve and expedite stockpiling operations at Los Alamos. Concerned about the slow rate of weapons development, Nichols proposed to turn over to outside contractors full responsibility for fabrication of most bomb components, making

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[32] The so-called redox solvent extraction process was based on the principle of alternating between the plutonium oxidation state and higher states to separate plutonium from uranium and then removing the fission products with other organic solvents, such as hexone. See MDH, Bk. 4, Vol. 6, pp. 4.24–4.26, DASA; Hewlett and Anderson, *New World*, p. 630.

[33] MDH, Bk. 2, Vol. 5, "Operations," pp. 4.1–4.12 and 8.1–8.4, DASA; Hewlett and Anderson, *New World*, pp. 629–30.

[34] Except as otherwise indicated, section on Los Alamos in 1946 based on MDH, Bk. 8, Vol. 2, Supp., passim, DASA; Groves, *Now It Can Be Told*, pp., 381–85.

[35] Ltr, Groves to Bradbury, 4 Jan 46, MDR; Hewlett and Anderson, *New World*, pp. 630–31.

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Los Alamos responsible for only the development of new types of bombs. The district engineer also recommended creation of a special technical military unit in the Manhattan District to do the final assembly work on bombs.[36]

One activity diverting many senior staff members at Los Alamos from weapons development was Operation CROSSROADS, the test of atomic bombs against naval vessels scheduled to take place in the early summer of 1946 at Bikini Atoll. After devoting many months to assembling and testing the weapons components, preparing a technical handbook, and furnishing much additional technical data, laboratory staff members were detailed to the Bikini site to help prepare for and to observe the two tests undertaken—Test Able, 30 June, the explosion of a bomb over a group of ships at a considerable altitude; and Test Baker, 25 July, detonation of a bomb under water. During the tests Col. Stafford L. Warren of the District's Medical Section supervised special radiation teams who—under the guidance of officers and men trained at the Clinton Laboratories, the Universities of Chicago and Rochester, the Philadelphia Navy Yard, and Los Alamos—carried out a variety of radiological safety procedures with radiation-detecting instruments.[37]

In the meantime, John H. Manley, a long-time and influential scientist on the laboratory staff, indicated to Groves and Nichols his support of the plan to relieve Los Alamos of most of the activities relating to actual weapons production. Manley objected to what he felt was a growing interference of the military with the program at Los Alamos. This, he thought, could be eliminated by turning over to a special military unit the production, stockpiling, and protection of atomic bombs, leaving to the civilian staff only bomb development. Groves had already organized a special Army battalion at Sandia Base to assume responsibility for surveillance, field tests, and weapons assembly. He also had worked out an agreement with Monsanto for development and fabrication of weapons components in a plant at Dayton, Ohio. Furthermore, he had started preliminary planning for the shift of uranium purification and its reduction to metal to Clinton and of similar operations on plutonium to Hanford. Thus, the way was almost clear for the scientists at Los Alamos to devote their full efforts to the design and development of new weapons.[38]

While attending to problems associated with postwar project operations, the Army inevitably became involved in a good many other administrative problems, some routine in nature. Illustrative of this type of activity was the settlement of various contractors' war claims against the project. Typical was a suit brought in early 1946 by Clifton Products, Inc., a metal processing firm, for losses of about $18,000 it claimed to have incurred in construction and operation of a beryllium plant. The company, in filing its claim with the Appeal Board of the Office of Contract Settlement, stated that the Manhattan District was one of several wartime agencies that had encouraged it to undertake production of beryllium. The Manhattan District informed the Judge Advocate General attorneys preparing the government's defense that the War Production Board, not Manhattan, had taken the initiative in persuading Clifton to build beryllium production facilities that were primarily for the benefit of other branches of the Army. The Appeal Board, nevertheless, decided in favor of Clifton. Consequently, in August 1946, the District's Madison Square Area Engineers Office had to negotiate a final financial settlement with the firm, agreeing upon payment of some $5,000 "for losses sustained." [39]

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[36] Memo, Nichols to Groves, 22 Mar 46, Admin Files, Gen Corresp, 410.2 (Metals), MDR.

[37] Groves, *Now It Can Be Told*, pp. 384–85; MDH, Bk. 8, Vol. 2, Supp., pp. I.13–I.17, and Vol. 3, "Auxiliary Activities," Ch. 8, DASA; *Radiology in World War II*, pp. 901–15. The Bikini tests were carried out under the overall direction of the Navy, although the District had technical responsibility for them.

[38] MDH, Bk. 4, Vol. 6, p. 4.25, and Bk. 8, Vol. 2, Supp., pp. VII.6–VII.7 and App. 9, DASA; Hewlett and Anderson, *New World*, pp. 632–33.

Disposition of surplus property was another routine activity that absorbed a good deal of time. Property disposal was a matter of considerable interest to the general public and therefore also to members of Congress. Typical of the problems that arose were those relating to the priority rights of veterans in the purchase of surplus government property. For example, Col. Elmer E. Kirkpatrick, Jr., now serving as deputy district engineer, had to assure Senator Edwin C. Johnson of Colorado that in the sale of Manhattan District materials and equipment at Grand Junction, where the project had secured uranium from vanadium tailings, "veterans are being given all possible consideration under the laws and regulations governing the sale of war contractor inventories. . . ." In another instance, Groves himself had to assure the two senators from Tennessee, Kenneth D. McKellar and Tom Stewart, that Roane-Anderson's sale of surplus property at Clinton would take into account the special rights of veterans. Complaints from constituents claimed that the firm had been disposing of property to the highest bidder without reference to veterans' rights. Groves pointed out that this disposition procedure was legal and had been done in the interest of expediting reduction of inventories as quickly as possible, but assured them that, in the future, every effort would be made to observe veterans' rights.[40]

A crucially important function that devolved upon the Army was the technical information program for individuals and groups with a need-to-know about the new source of energy and its military and industrial applications. The secret circumstances under which atomic energy had developed, combined with its relative newness as a major field of scientific knowledge, placed upon a comparatively small group of military and technical experts the formidable task of educating and indoctrinating a vast number of military men, government officials, industrial engineers, business executives, scientists and technicians, medical personnel, and a great many other people. Groves was often called upon to brief the Secretary of War, Chief of Staff, and other officials in the military services, and to speak before conferences of military officers. Frequently, too, he and many project members were called to testify before the committees of Congress considering domestic legislative proposals and to assist those government officials charged with shaping postwar policies for the international control of atomic energy.[41]

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[39] On the claim filed by Clifton Products see Memos, Capt John L. Davies, Jr. (Mad Sq Area Engrs Office) to Nichols, 9 Jan 46, and Lt Col Cooper B. Rhodes (Mad Sq Area Engrs Office) to Groves and Nichols, 28 Aug 46, and also Ltr (source of quotation), Groves to Appeal Board, 30 Aug 46, Admin Files, Gen Corresp, 156 (Clifton Products), MDR.

[40] Quotation from Ltr, Kirkpatrick to Johnson, 1 Mar 46, Admin Files, Gen Corresp, 400.7 (Disposition of Equip), MDR. See also Telgs, Knoxville Post No. 2, American Legion, Dept. of Tenn., to McKellar and Stewart, 5 Aug 46, Incls in Ltrs, McKellar and Stewart to Groves, 9 Aug 46; Ltr, Groves to McKellar and Stewart, 14 Aug 46. All in Admin Files, Gen Corresp, 400.703, MDR. See memo routing slip attached to the 14 August letter for additional comments by Groves, who wrote that the District's procedure on the sale of surplus property had provided some justification for the complaints and that corrective action would now be taken to ensure full observation of veterans' rights.

The Final Act: Transfer to Civilian Control

With the President's signing of the Atomic Energy Act on 1 August 1946, the United States Atomic Energy Commission was created as the civilian successor agency for the Army. This commission, to consist of five full-time presidential appointees, would oversee the domestic atomic energy program by assuming responsibility for most of the activities of the Manhattan District, including the production, ownership, and use of all fissionable materials in the United States; for sponsorship of the extensive research and development program in government laboratories, universities, and elsewhere; for control and release of restricted scientific information; for enforcement of security and safety; and for military application of atomic power.

Yet enactment of this long-awaited legislation did not immediately relieve the Army of its stewardship of the domestic program. The contributing factors were many. The President experienced extended delays in securing the individuals he wanted to serve as commissioners, whose names he did not announce until the end of October. Once appointed, the new commission requested General Groves to delay the official act of transfer until 1 January 1947. In retrospect, the Manhattan commander remembers the period from August through December 1946 as one of the most difficult of his entire time as head of the project, because "everyone knew that I was in a caretaker's position, and they had no assurance that my views would be those of the Commission. After the commissioners were finally appointed, it was quite evident that my views would not be accepted without a long-drawn-out delay." [42]

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[41] On the military application of atomic energy see OCG Files, Gen Corresp, MP Files, Fldr 1, Tabs A–D, MDR, especially Tab D for Memo, Groves to Chief of Staff, sub: New Wpns Development, 12 Feb 46, and OCG Files, Gen Corresp, Groves Files, Fldr 8, MDR, for Talk, Groves to Mil Conf (Fort Belvoir, Va.) Attendees, sub: Hist of Manhattan Proj, 23 Sep 46. On the indoctrination of engineers see Groves, *Now It Can Be Told*, pp. 387–88. One of those who took the training offered at Oak Ridge was Capt. Hyman G. Rickover, who subsequently was assigned to direct the Navy's program for development of the atomic submarine.

[42] Groves, *Now It Can Be Told*, p. 395. Except as otherwise indicated, section on the transfer of the atomic energy program from the Manhattan Project to the Atomic Energy Commission based on Memo, Aurand to Secy War, sub: Mtg With Groves, 5 Jul 46, 471.6 (Atomic Bomb); Memo, Groves to Secy

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During this difficult period, there was little the War Department and the Manhattan District could accomplish beyond making plans for transferring project control until the President appointed the new commissioners. Secretary Patterson, in particular, was anxious to have the transfer go smoothly and took steps to provide for continued Army liaison with the commission. At his request, General Groves and Maj. Gen. Henry S. Aurand, the General Staff's director of research and development, discussed tentative measures for dealing with the problems that would arise when the military personnel assigned to the Manhattan District would have to be absorbed by the Army. From their discussions evolved the proposal to set up within the War Department an atomic energy committee, comprised at least in part of those Army officers who would also be assigned to the commission's Military Liaison Committee.

The President announced the five members of the Atomic Energy Commission on 28 October. To the post of chairman, he named David E. Lilienthal who, as head of the Tennessee Valley Authority, had gained considerable knowledge of project activities at Clinton and had served as a member of the State Department panel on international control of atomic energy. For the other four positions, the President selected Robert F. Bacher, a Cornell physicist who had played a leading role at Los Alamos; Sumner T. Pike, editor of the *Des Moines Register and Tribune* and a Pulitzer Prize winner; William W. Waymack, a former member of the Securities and Exchange Commission; and Lewis L. Strauss, a Navy reservist who had served during the war in the Bureau of Ordnance and as an assistant to the Secretary of the Navy.

While awaiting official announcement of his appointment, Lilienthal had formed a temporary administrative staff comprised of individuals that had worked together with him on atomic energy matters. He selected Herbert S. Marks, director (acting) of the War Production Board's Power Division before becoming Dean Acheson's assistant at the State Department; Joseph Volpe, Jr., a former military officer on the legal staff in General Groves's Washington headquarters; and Carroll L. Wilson, a wartime assistant to Vannevar Bush at the Office of Scientific Research and Development. Myriad housekeeping arrangements for the new commission required the immediate attention of Marks, Volpe, and Wilson, who worked out most of the details with Lt. Col. Charles Vanden Bulck, chief of the District's Administrative Division. Pressed by the commissioners' impending arrival in early November, Vanden Bulck expedited all requests from the staff for funds, for office space in the New War Department Building, which was adjacent to

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War, sub: Mil Liaison Committee, AEC, 17 Jul 45, 352.13; Ltr, Secy War to Groves, 15 Sep 46, 319.2 (Misc); DF, Maj Gen Lauris Norstad (Plans and Opns Dir, WDGS), sub: WD Atomic Energy Committee, 19 Sep 46, 334 (Mil Liaison Committee); Memo, Groves to Secy War, sub: WD Atomic Energy Committee, 18 Sep 46, 334 (Atomic Committee on AE); Memo, Groves to Chief of Staff, sub: Turnover to AEC, 31 Dec 46, 352.13; Ltr, Groves to Lilienthal, 20 Dec 46, 201 (Lilienthal, D. E.); Memo, Brereton to Groves, sub: Comments on Proposed Memo to Secy War, 26 Dec 46 (Org-AFSWP); Draft Ltr, Groves to Lilienthal, 28 Dec 46, 319.2 (Misc). All in Admin Files, Gen Corresp, MDR. Hewlett and Anderson, *New World*, pp. 620–24 and 634–55.

Groves's headquarters, and for clerical support.

In early November, after winding up personal affairs and relocating to Washington, the commissioners collectively channeled their energies and talents to prepare for the transfer of the atomic program from military to civilian control. As a first measure, they directed their staff to arrange briefings and inspection tours of the District's various installations. Lilienthal, joined by Bacher and Pike, visited District headquarters at Oak Ridge on the fourth. Nine days later, accompanied by Marks, Volpe, and Wilson, all five commissioners undertook a tour of the major atomic reservations and research facilities. By the time they returned to Washington on the twentieth, they were considerably more familiar with the character and problems of the Manhattan Project and were ready to proceed with carrying out the formal transfer.

Meanwhile, the Army had moved ahead with steps to facilitate the transfer. From a list of candidates prepared largely by the Manhattan commander, the Secretaries of War and the Navy had selected three members for the commission's Military Liaison Committee—Air Force Lt. Gen. Lewis H. Brereton, as chairman; Rear Adm. Thorvald A. Solberg, who had participated in the Operation CROSSROADS tests; and Rear Adm. William S. Parsons, who had seen long service on the atomic project's Los Alamos technical staff—that would administer any military functions transferred from the Manhattan District.[43] Groves, who had designated Nichols to function as his point of liaison with the commission, also attempted to secure the appointment of the district engineer to fill the commission post of director of the Division of Military Application.

But the commissioners expressed a desire for a clean break with the past military administration of the project. Moreover, because they disagreed with Nichols's view that the division should function as a "line" rather than a "staff" organization, as well as with his strong advocacy of military custody of atomic weapons, they requested the Secretary of War to submit other nominees for the position. Their rejection of Nichols was evidence of an enduring suspicion that the Army was still trying to retain a dominant influence in the field. This mistrust, a legacy of the prolonged legislative fight over the issue of military versus civilian control, exacerbated what might otherwise have been essentially a formality.[44]

Consistent with provisions of the Atomic Energy Act, the commission in early December informed General Groves that it planned to take over full responsibility for the atomic project as of 1 January 1947. As of that date, the Manhattan District was, without exception, to transfer all property and functions of the project to the commission, which subsequently would retransfer such property and functions deemed more appropriate for armed services control. Groves and Nichols promptly and firmly objected to this proposed procedure. Their reasons were straightforward: Certain properties—for example, all ordnance works (except the heavy water facilities), Sandia Base at Albuquerque, and weapons storage sites—should not be transferred even temporarily; the raw materials function should remain under Army control until the commission became a member of the Combined Development Trust; and intelligence operations and records should be transferred directly to the new Central Intelligence Group, not via the commission.

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[43] Subsequently, both Generals Groves and Nichols served as Army members of the Military Liaison Committee—Groves from 2 Feb 47 to 29 Feb 48 and Nichols from 29 Feb 48 to 1 Feb 51.

[44] On Nichols's rejection as nominee for the position of director of the Division of Military Application see Nichols, Comments on Draft Hist "Manhattan," Incl to Ltr, Nichols to Chief of Mil Hist, 25 Mar 74, CMH, and Hewlett and Anderson, *New World*, p. 653. On the issue of custody of weapons see Hewlett and Duncan, *Atomic Shield*, p. 585. This issue remained in dispute until September 1952, when an agreement was reached that the military would control the greater share of the stockpile of atomic weapons.

In spite of Groves and Nichols's objections, the commission indicated that it intended to adhere strictly to the concept of transfer and retransfer. Regardless of this resolute stance, Nichols met with the commission on several occasions in mid-December and sought—but without success—to secure a modification of its position, fighting particularly hard for military custody of atomic weapons. On the last-named issue, Nichols seems to have achieved some measure of success, for at the end of the month the commission informed the Secretary of War that, while it was not willing to give up its basic insistence on a simple, all-inclusive transfer, it would consider some concessions. As its concessions, the commission agreed to accept only nominal transfer of properties relating to weapons, ordnance parts, and fissionable materials; to consider arrangements for retransfer of these properties to Army control not later than 1 March 1947; and to resolve the question of membership in the Combined Development Trust. On the issue of intelligence, it refused to take action until it had more information.

The last days of December were unbelievably hectic for the commission, which participated in a series of hurried conferences at the State and War Departments in an attempt to clear the way for agreement on the unresolved aspects of the raw materials and intelligence issues. At the State Department, it worked out an arrangement that involved eventual disbandment of the Combined Policy Committee (its continued existence appeared to be in serious conflict with provisions of the Atomic Energy Act) and membership in the Combined Development Trust, provided that Congress was informed of this hitherto secret wartime agency. At the War Department on the thirtieth, Lilienthal briefed the Secretary of War on the commission's arrangement with the State Department. Patterson was satisfied and thereupon agreed to transfer the Army's raw materials function. After discussing the remaining points in dispute on intelligence, Lilienthal determined the Secretary's position was immutable. Pressed by the 1 January deadline, the commission chairman resorted to a compromise. He agreed that the function temporarily should remain with the Army, provided that the commisson's staff was given an opportunity to examine all the records.

The last formal procedure in the transfer occurred at the White House on the afternoon of 31 December.

TRANSFER OF CONTROL TO THE ATOMIC ENERGY COMMISSION. *Seated, left to right: Carroll L. Wilson, President Harry S. Truman, David E. Lilienthal. Standing, left to right: Sumner T. Pike, Colonel Nichols, Secretary of War Patterson, General Groves, Lewis L. Strauss, William W. Waymack.*

Four of the five commissioners (Bacher was inventorying weapons at Los Alamos) and Carroll Wilson, recently appointed general manager of the commission, joined with Patterson, Groves, and Nichols in President Truman's office to witness the final act: the signing of the executive order that legally ended the Army's stewardship of the atomic energy program and turned over peacetime control and development of the atom to a commission of five men.[45]

For a period of sixteen months following the end of the war, the Army had carried out the often perplexing and thankless task of administering, on an interim basis, an atomic organization undergoing the severe stresses and strains of transition from a war to a peacetime status. Compounding the problems of what was inherently a difficult assignment was the widespread disagreement among the American people as to precisely what kind of organization was best suited to develop and control in peacetime so significant a new source of energy. By mid-1946, many Americans were disappointed and disillusioned because the "golden atomic age," widely predicted when news of the wartime atomic energy program was first made public, had failed to materialize, and the tendency was to blame the Army for this. Yet, as General Groves pointed out in retrospect, the Army had accomplished during its trusteeship what was perhaps most essential to the long-range future of atomic energy in the United States. It had preserved and turned over to its new civilian administrators "a good organization—one ranked among the top industrial organizations of the country—and [achieved] the orderly demobilization of its forces to fit into the organization of the Atomic Energy Commission." [46]

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[45] The Manhattan Project officially came to an end with the signing of the executive order and transfer of the atomic program to the Atomic Energy Commission, although the Manhattan District was not abolished until 15 Aug 47 (see MDH, Bk. 1, Vol. 1, "General," p. F2, DASA). Early in 1947, the Secretaries of War and the Navy established the Armed Forces Special Weapons Project (AFSWP), effective 31 Dec 46, to assume all of the functions of the Manhattan Project that had not been transferred to the commission. Organized as a joint agency in anticipation of the unification of the military services, the AFSWP was responsible for their participation in the development of atomic energy for military purposes. On the establishment of the AFSWP see Groves, *Now It Can Be Told*, pp. 398–400; Hewlett and Duncan, *Atomic Shield*, pp. 131–32; and Draft WD Cir, sub: AFSWP, 7 Feb 47, and Ltr, Col J. W. Brown (Secy, Gen Staff) to Groves, sub: Appointment of Groves as AFSWP Chief, 28 Feb 47, both in Admin Files, Gen Corresp, 322 (Org-AFSWP), MDR.

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[46] Quotation from Statement by General Groves on dissolution of Manhattan Engr Dist, 14 Aug 47, MDR.

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EPILOGUE

An Atomic Legacy

The advent of the atomic age—and its concomitant legacy of not only great benefits but also great risks—emanated from the Manhattan Project. In the history of technological development in the Western world, America's atomic energy program constituted a unique episode: Through an integrated synergy of science, industry, and the military, the men of Manhattan created a revolutionary new device, the atomic bomb, unleashing for the first time the power within the atom.

Ever intrigued by the phenomenon of the atom, particularly its vast stores of energy, men in past centuries had frequently endeavored to discover means to release this power. These efforts consistently failed, however, and the potential of the atom remained a matter of theory, a hypothesis graphically realized only in the imaginative world of science fiction. Ongoing research by a small group of European physicists in the early years of the twentieth century finally culminated in the late 1930's with Hahn and Strassmann's demonstration of the feasibility of fissioning the atom, the key to tapping its enormous energy. But repressive political and ideological conditions abroad occasioned many of these physicists to forego their scientific investigations and to seek refuge in America. There, World War II provided them the opportunity to apply their research—to transform atomic theory into a material reality—as they collaborated with American scientists, engineers, and industrialists under the direction of the United States Army on the project to produce the world's first atomic weapon.

During the course of this unprecedented undertaking, the Army had a significant role in orchestrating almost every aspect of atomic development—from the design, construction, and operation of large-scale production plants to strategic planning for the employment of the atomic bomb. Until 1942, its participation in the atomic energy research carried on largely by the refugee and American scientists at various government and university laboratories under the auspices of the Office of Scientific Research and Development and its predecessors was sporadic and peripheral. Yet the scientific leaders of the OSRD program, having full cognizance of the military potentialities of atomic energy, had anticipated that the Army, or an equivalent agency, eventually would have to assume a leading part in its development. The juxtaposition of a number of factors in the winter of 1941–42, including the sudden entrance of the United States into World War II, the prevailing belief that the Germans were moving ahead with their own atomic investigations, and the rapid approach of the American program to the pilot plant stage, convinced them that this time had come. Hence, in early 1942, they advised the President to take the measures necessary to bring the Army into the program on a major scale.

As a first step, Army Chief of Staff General George C. Marshall selected Brig. Gen. Wilhelm D. Styer of the Services of Supply to establish liaison between the Army and the atomic program. General Styer, working with the OSRD leaders, particularly Vannevar Bush and James B. Conant, drew up plans for bringing the Army more fully into the program. Approval of these plans in June 1942 by the Top Policy Group—the President, Vice President, the Secretary of War, Marshall, Bush, and Conant—marked the start of the Army's managerial role in the most revolutionary enterprise of its time.[1]

The program approved in June turned over to the Army three important tasks: design, construction and operation of plants to produce fissionable materials; organization of a special laboratory to design, manufacture, and test atomic weapons; and responsibility for security for the entire project. Under the provisions of the program the Army was to work in close coordination with the OSRD, which would continue to administer the research and development aspects, and to use the funds and the facilities of its Corps of Engineers in carrying out its new assignment.

To discharge these tasks, the Army selected Col. James C. Marshall, an engineer officer with broad construction experience and a reputation for high professional competence, as manager of the atomic energy program. During the summer of 1942, Marshall, drawing chiefly upon Corps personnel, facilities, and practices for administering large-scale construction projects, laid the groundwork for the Army's. atomic infrastructure. He formed a new engineer district, with headquarters temporarily in New York City, and appropriately named it the Manhattan District. But by September, the project's military and civilian leaders had come to realize that development of an atomic weapon was going to require an enterprise of far greater scope and complexity than they earlier had anticipated. Consequently, they agreed to the appointment of an Army officer who would be assigned overall responsibility for not only the District but also all other aspects of the wartime atomic program. To fill this key position, the Army designated Col. Leslie R. Groves, a career engineer officer who, while serving in the Corps' Construction Branch, had consistently demonstrated an exceptional ability to complete difficult large-scale construction projects. At the same time, the project leaders also created a Military Policy Committee, comprised of Bush, Conant, Styer, and Rear Adm. William R. Purnell, representing the Navy, to broadly control and oversee the Army's management of the program.

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[1] Ltr, Bush to President, 17 Jun 42, and Incl, HB Files, Fldr 6, MDR.

The assignment of Groves had an immediate and significant influence on the subsequent development of the atomic energy program. As a professional manager, Groves, newly promoted to brigadier general, was energetic, hard-working, and aggressive to a fault, single-minded yet adaptable when flexibility was necessary, and well equipped both by education and experience to oversee and direct a highly technical and complex construction project under the often difficult conditions existing in wartime. Skillfully using his dual position as, in effect, the executive secretary of the Military Policy Committee and chief administrative officer of what came to be known as the Manhattan Project, Groves quickly established dominant control over the rapidly expanding program. In late 1942 and early 1943, making maximum use of the authority granted from the War Department to use existing facilities of the Corps of Engineers (such as the Real Estate Branch), of other branches of the Army (such as the Medical Corps and Military Intelligence Division), of other government agencies (such as the United States Employment Service and Tennessee Valley Authority), Groves succeeded—despite severe shortages and competition from other wartime programs—in securing the priorities, land, materials, tools, manpower, and other requirements essential to the Manhattan Project's continued development. The Manhattan commander's adoption and implementation of this management practice of securing, whenever feasible, assistance from other military and civilian agencies made it possible for him to organize and direct effectively the multifarious activities of the project, aided only by a headquarters staff that was extremely small by wartime standards.

Contributing also to Groves's success as the top manager of the Manhattan Project was the skill and dedication of his team of middle managers—including District Engineer Marshall and, following the relocation of the Manhattan District headquarters to Oak Ridge, his replacement, Col. Kenneth D. Nichols; Lt. Col. Franklin T. Matthias, in charge of the Hanford Area Engineers Office; and the four key scientific directors: J. Robert Oppenheimer of the Los Alamos Laboratory, Arthur Compton of the Metallurgical Project, Ernest Lawrence of the Radiation Laboratory, and Harold Urey of the SAM Laboratories. Faced with the vast scope and complexity of the atomic program, the task of each project manager was to keep the diverse activities of his installation focused on Manhattan's primary goal: production of an atomic weapon. Working in close coordination with Groves in Washington, each manager established specific project objectives, organized operational functions, measured performance and compliance with schedules, and motivated and developed personnel resources to administer the far-flung research, construction, and production aspects of an enterprise which, at its height of activity, employed a work force of nearly 129,000.

A relatively small proportion of this work force, some thirty-six hundred military and civilian personnel assigned directly to Manhattan or its

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university contractors, comprised the project's administrative core element. Members of this group found themselves with responsibilities for carrying out a great variety of activities. Many assignments were quite similar to those they had experienced as employees of the Corps of Engineers or other government agencies. These included monitoring the negotiations and implementation of contracts and subcontracts; expediting procurement of materials and manpower; assisting in site selection and acquisition; enforcing security, health, and safety regulations; and overseeing the construction and administration of the atomic communities in Tennessee, New Mexico, and Washington State. Other assignments, however, were new and unlike anything hitherto undertaken by uniformed or civilian employees of the Army. These included overseeing the worldwide search and exploration for deposits of uranium, thorium, nickel, and other vital raw materials required by the project; working as scientists and technicians in research laboratories; serving as diplomatic agents in treaty negotiations with foreign governments; and making significant contributions to planning for the peacetime control and use of atomic energy at home and abroad.

Participation in the atomic energy program was by no means limited to personnel assigned only to the Manhattan District or the Corps of Engineers. Many of the Army's key officials, staff components, and subordinate elements became involved in the program and contributed to its ultimate success. For example, the Secretary of War himself assisted in maintaining essential liaison between the Manhattan Project and the President and Congress and played an important role in planning for the tactical employment of the bomb and the postwar control of atomic energy. The staff of the Under Secretary of War proved indispensable to Manhattan in solving numerous manpower procurement and labor problems. The Ordnance Department made available existing munitions plants that facilitated development of heavy water production works. The Signal Corps installed vital communications systems that ensured adequate coordination of complex activities at the widely separated and isolated installations. Military Police and Military Intelligence units performed key security functions. The Medical Corps furnished the personnel for the health and medical facilities. And when the atomic bombs were ready for combat employment, the Army Air Forces provided the B-29 aircraft and crews for delivering them on enemy targets.

There are few who would question that the development of atomic energy and atomic bombs under the Army's direction was one of mankind's greatest technical and military achievements—one that the Army shares, of course, with American science and American industry. The nation's political leaders in the early months of America's participation in World War II had concluded that the Army was the organization best suited, and perhaps the only one able, to undertake the responsibility for administering a program of the magnitude and difficulty of the Manhattan Project. The events of the summer of 1945 proved the soundness of their choice, for the Army carried out its

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unenviable mission with success that certainly matched its achievements on the battlefields of World War II. General Groves succinctly summarized the breadth and significance of this accomplishment in his farewell message to the men of Manhattan:

> Five years ago, the idea of Atomic Power was only a dream. You have made that dream a reality. You have seized upon the most nebulous of ideas and translated them into actualities. You have built cities where none were known before. You have constructed industrial plants of a magnitude and to a precision heretofore deemed impossible. You built the weapon which ended the War and thereby saved countless American lives. With regard to peacetime applications, you have raised the curtain on vistas of a new world.[2]

Undeniably, in the history of technology, the Manhattan Project stands as a spectacularly successful venture, having demonstrated to the world the kind of technical miracles possible when, through skillfully applied management techniques, the resources of science and industry are brought to bear single-mindedly on the resolution of extremely complex technological problems. But there are those who have suggested that the Army's participation in the project was not necessary at all—that science alone, with civilian industry's help, would have been able to build the fissionable materials production plants and to perfect the bomb. Some have even indicated that the Army's entry into the atomic program brought a bureaucratization, perhaps most dramatically exemplified in the policy of compartmentalization, that unnecessarily restricted and slowed the development of the bomb. These Army policies left an aftermath of resentment and suspicion, which found expression after the war in a long and bitter controversy over enactment of legislation for peacetime control of atomic energy. And the American public's ultimate solution was to give a civilian agency, the United States Atomic Energy Commission, the dominant control over the new source of energy.

In compliance with the people's mandate—a decision that represented probably not so much a criticism of the Army's role in the Manhattan Project, as it did a continuing adherence to the traditional American belief in subordinating the role of the military in peacetime—the Army on 31 December 1946 passed on to the Atomic Energy Commission primary responsibility for the future development and control of atomic energy. And even as the Army completed its final act, some of the correlative benefits and risks of the atomic legacy that it had done so much to create were already discernible. Hiroshima and Nagasaki had revealed the power, and the horror, of an atomic bombing, forecasting the urgent need for an international alliance to control nuclear weapons that, if left uncontrolled, threatened the existence of civilized society. But the fissioning process that had made possible the release of the enormous energy within the atom also gave promise of providing vast amounts of heat for generating electricity and useful radioactive isotopes for industrial and medical application. In the years ahead, while having a lesser role in atomic matters as a member of the commission's Military Liaison Committee and, subsequently, the Armed Forces Special Weapons Project, the Army—as an integral institution of American society—would continue to share in the atomic legacy.

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[2] Quotation from Groves's farewell message to Manhattan Proj, 23 Dec 46, Admin Files, Gen Corresp, 316, MDR.

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Appendix—Einstein's Letter

Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island
August 2d, 1939

F. D. Roosevelt
President of the United States
White House
Washington, D.C.

Sir:

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations.

In the course of the last four months it has been made probable—through the work of Joliot in France as well as Fermi and Szilard in America—that it may become possible to set up a nuclear chain reaction in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable—though much less certain—that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is the Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence who could perhaps serve in an unofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problems of securing a supply of uranium ore for the United States.

b) to speed up the experimental work, which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the co-operation of industrial laboratories which have the necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizaecker, is attached to the Kaiser-Wilhelm-Institut in Berlin where some of the American work on uranium is now being repeated.

Yours very truly,[1]
(signed) *A. Einstein*

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[1] Original of letter and inclosures filed in FDR.

Bibliographical Note

Unpublished Sources

Archival Collections

Manhattan: The Army and the Atomic Bomb is based primarily, although not exclusively, upon the archival records created by the Manhattan Project from 1942 to 1948. Physical control of the bulk of these records is divided between two federal agencies—the National Archives and Records Service (NARS) and the Department of Energy (DOE). A useful guide to records in the custody of NARS is its *Inventory of the Records of the Manhattan Engineer District, 1942–1948* (Washington, D.C., November 1956). As yet, DOE has not published a similar guide for its records, but each of its records centers maintains a catalog of its holdings. All footnote citations include sufficient data for locating Manhattan Project archival records in their respective depositories, indicated by a final two-, three-, or four-letter abbreviation that is fully identified in the Guide to Archival Collections. For reasons of brevity, in each chapter only the initial citation of a document gives the full reference data (MPC Rpt, 15 Dec 42, OCG Files, Gen Corresp, MP Files, Fldr 25, Tab B, MDR); subsequent citations are shortened references that contain the essential identifying elements, followed by the appropriate depository code (MPC Rpt, 15 Dec 42, MDR).

The Manhattan District records at NARS fall into several major categories, of which three are of particular interest. Relating primarily to high-level policymaking matters are the records of General Groves's Manhattan Project headquarters in Washington, D.C., designated the Office of the Commanding General Files; and those of Secretary Stimson's office, designated the Harrison-Bundy Files (for George Harrison and Harvey Bundy, Stimson's principal assistants). Relating primarily to the Army's practices and problems as administrator of the Manhattan Project are the General Administrative Files.

The Office of the Commanding General Files are comprised of letters, memorandums, directives, diaries, reports, and similar materials that concern a variety of topics—including organization, research, production, stockpiling, weapon testing, domestic and international control, security, and foreign personnel. Of special value is the diary of Col. (later Brig. Gen.) James C. Marshall, the first district engineer, which records in detail the early months (June–October 1942) of the Army's administration of the atomic bomb project, and the *aide-memoire* notebook of Groves, which covers the activities of the commanding general from May 1943 to May 1945. This file group, however, does not include the similarly useful office diary (1942–46) of Groves, which is retired in NARS Record Group 200.

The Harrison-Bundy Files contain the letters, memorandums, and cables on atomic energy that were exchanged between the Secretary of War, his assistants, the Under Secretary of War, the Chief of Staff, various scientists, and appropriate representatives of the British and Canadian governments. In addition to correspondence, the files include minutes of the meetings of the Military Policy Committee, the Combined Policy Committee, and the Interim Committee; a documentary diplomatic history of the Manhattan Project prepared at the direction of General Groves; and various drafts of bills for domestic control of atomic energy drawn up by War Department personnel, copies of speeches, press releases, and reports to Congress.

The General Administrative Files consist primarily of correspondence between the District's military and civilian personnel and the project's scientists and engineers, as well as between individuals in the War Department and the various field offices of the District. In addition, these files contain copies of the District's circular letters, memorandums, and bulletins, touching upon such matters as audits, civilian and military personnel, contracts and claims, costs, finance, insurance, labor relations, organization, equipment, safety, transportation, priorities, and property.

Other categories of Manhattan District records at NARS pertain to a number of disparate project activities. The Investigation Files include correspondence, memorandums, and proceedings related to personnel security and criminal investigations. The Fiscal and Audit Files contain useful information concerning operating costs at specific installations and data compiled for budget planning. The Foreign Intelligence Files are comprised of letters, messages, and reports of the District intelligence offices established in early 1944 in London, Paris, and Frankfurt.

Besides the formal collection of Manhattan District records, NARS also has other extensive materials pertinent to the wartime atomic bomb project, including Office of Scientific Research and Development (OSRD), congressional, and Department of State records. Those from OSRD are essential for the history of the project before the Army's entrance into it in 1942 and for the views of scientists, especially Vannevar Bush and James B. Conant, on such subjects as postwar planning for control of atomic energy. The hearings on enactment of postwar legislation by the Senate Special Committee on Atomic Energy in 1945–46, as well as other congressional records, include considerable historical information concerning development of the wartime project. State Department records contain important data on American policy relating to postwar international control measures.

At the time of the writing of this volume, most of the day-to-day administrative, construction, and operational records of the Manhattan

oject (such as contracts, construc-
n completion reports, security and
rsonnel records, and periodic re-
rts on research and development
rograms, plant operations, and com-
unity functions) were located in the
OE facility at Germantown, Mary-
nd, and in the several DOE- or con-
actor-operated records centers at
OE field installations. Most of these
ecords, however, will eventually be
etired to the appropriate regional
epositories in the NARS system.

By far the largest and most impor-
ant collection of DOE records was in
he Oak Ridge Operations Office. It
ontained not only the central mail
nd records files of the Manhattan
District headquarters but also those of a number of other important subordinate elements of the project (for example, the Washington Liaison Office and the District's area offices in New York City). Here also were the records on the design, construction, and operation of the electromagnetic, gaseous diffusion, and thermal diffusion plants, as well as the plutonium semiworks, and on the planning, building, and administration of the Oak Ridge community. Of special value were the construction completion reports of Stone and Webster, M. W. Kellogg and Kellex, Du Pont, and other major contractors, and the diary (1943-46) of Col. E. H. Marsden, executive officer in the district engineer's office.

Records in the Hanford Operations Office documented the story of the plutonium production plant. Du Pont, the major contractor, produced voluminous historical reports on site development and plant and community construction and operations. The area engineer, Col. Franklin T. Matthias, recorded the Army's role at Hanford in a detailed diary (1943–46).

The bulk of the source materials on scientific and technological developments in the atomic bomb program were in DOE's major contractor-operated research centers. These include the Argonne National Laboratory at Lemont, Illinois, which has the files of the Metallurgical Project; the Lawrence Radiation Laboratory at Berkeley, California; and the Los Alamos Scientific Laboratory at Los Alamos, New Mexico. The records of the SAM Laboratories at Columbia University were in the Oak Ridge Operations Office.

Personal Papers

In the years since the end of World War II, the personal papers of many of the statesmen, military leaders, and scientists who played important roles in development of the atomic bomb have become available for historical research. Papers of Franklin D. Roosevelt and Harry L. Hopkins are in the Roosevelt Library at Hyde Park, New York, as well as some of those of Vannevar Bush pertaining to the atomic project. Harry S. Truman's papers are in the Truman Library at Independence, Missouri. Those of Henry L. Stimson, including the indispensable personal diary (1939–45), are in Yale University's Sterling Memorial Library in New Haven, Connecticut. Most of General Groves's personal papers are in the National Archives, as are those also of Lyman J. Briggs, director of the National Bureau of Standards (1932–46). The Manuscript Division of the Library of Congress has the J. Robert Oppenheimer papers and a substantial portion of those of Bush. Papers of Enrico Fermi and some of those of James Franck, the British scientist, are in the University of Chicago Library and those of Ernest O. Lawrence are in the Bancroft Library, University of California at Berkeley. The voluminous diaries of William Lyon Mackenzie King, the Canadian political leader, are in NARS and contain many entries concerning wartime atomic energy development.

Manuscript Histories

There are several manuscript histories that cover all or important aspects of the atomic bomb project. The most extensive and comprehensive is the Armed Forces Special Weapons Project's "Manhattan District History," prepared at the direction of General Groves and under the general editorship of Gavin Hadden, a longtime civil employee of the Corps of Engineers. Conceived as the official history of the Army's role in the project, it consists of historical narratives prepared by each of the programs and activities of the Manhattan Project in accordance with a general plan of organization and list of topics to be treated. Many of the narratives are amply supplemented with appropriate supporting documents, bibliographies, charts, statistical tables, engineering drawings, maps, and photographs. The "History" is arranged in some thirty-six volumes grouped in eight books, with detailed general indices to names of persons, agencies, and subjects. Copies of the "History" are located in NARS and in DOE's Germantown facility. In 1962, the Los Alamos Scientific Laboratory published an unclassified version of a major portion of that part of the "History" that covered its activities from 1943 to 1947 (*Manhattan District History: Project Y, The Los Alamos Project,* LAMS-2532, 2 vols.). Extensive extracts from the "History" also are published in Anthony Cave Brown and Charles B. MacDonald, eds., *The Secret History of the Atomic Bomb* (New York: Dial Press/James Wade, 1977).

Other manuscript historical accounts cover specific aspects of the project. On the international activities of the atomic program, there is the "Diplomatic History of the Manhattan Project," compiled by members of General Groves's staff. Brief narrative sections, intended to justify involvement of Manhattan personnel in the international field, are supported by a useful selection of pertinent documents. Copies are held by DOE, the State Department, and NARS (in the Harrison-Bundy Files).

Several manuscript histories provide information on the extensive support that the Manhattan Project received from other elements of the Army's wartime staff. In this category are Richard M. Leighton's "History of the Control Division, ASF, 1942–1945" (in two volumes); several manuscript histories pertinent to military intelligence activities, including Bruce W. Bidwell's "History of the Military Intelligence Division, Department of the Army General Staff" (Part 5), Capt. C. J. Bernardo's "Counterintelligence Corps History and Mission in World War II," the Army Service Forces' "History of the

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Intelligence Division" (in four volumes), and the Office of the Provost Marshal General's "The Loyalty Investigations Program"; and the Army Service Forces' documentary "History of the Research and Development Division, 1 July 1940–1 July 1945, with Supplement to 31 December 1945" (in three volumes). Also, a section in Vernon E. Davis's "Organizational Development: Development of the JCS Committee Structure" (Volume 2) describes how the atomic program was coordinated with the other armed services. Copies of all these manuscript histories are in NARS.

Some of the many hundreds of firms that were under contract to the Manhattan Project prepared accounts of their activities that are more comprehensive and detailed than the usual contractor's completion report. Of considerable importance are those of the Du Pont Company on the design and construction of the Clinton semiworks and on the building and operation of the Hanford Engineer Works. Useful, too, are the histories produced by Roane-Anderson concerning its management of the town of Oak Ridge and of passenger transportation at the Clinton Engineer Works. Copies of contractor histories are in the appropriate DOE field records centers.

Interviews and Correspondence

Recollections of participants recorded in interviews and correspondence gave the author information that often supplemented the official archival records. Except where otherwise indicated, copies of interview notes and correspondence with the following persons are on file in the U.S. Army Center of Military History: Col. Keith F. Adamson; Col. Whitney Ashbridge; Col. Maurice E. Barker; James Phinney Baxter 3d; Maj. Samuel S. Baxter; Lt. Col. Benjamin R. Bierer; Lt. Col. Robert C. Blair; Harvey H. Bundy (in Columbia University Oral History Collection); Elkin Burckhardt; Charles W. Campbell; Lt. Gen. Frederick J. Clarke (in Corps of Engineers, *Engineer Memoirs: Interviews With Lieutenant General Frederick J. Clarke*); Karl P. Cohen; Winston Dabney; Col. Peer de Silva; Brig. Gen. John H. Dudley; Maj. Harold A. Fidler; Col. Mark C. Fox; F. A. Gibson; Lt. Gen. Leslie R. Groves; Lt. Gen. Richard H. Groves; Edith E. Hagg; Norman Hilberry; F. E. Jochen; Col. Elmer E. Kirkpatrick, Jr.; Col. Harry A. Kuhn; Brig. Gen. James C. Marshall; Col. Franklin T. Matthias; Pat McAndrew; Maj. William R. McCauley, Jr.; Francis McHale; Maj. John H. McKinley; Edwin M. McMillan; Duncan McRae; Capt. William J. Morrell; Lt. Col. Edgar J. Murphy; John Musser; S. H. Nelson; Charles E. Normand; Jean O'Leary; Harry Parker; David Piccoli; Maj. Gen. William N. Porter; Robert Y. Porton; W. B. Reynolds; Frederick J. Roach; Brig. Gen. Jacquard H. Rothschild; Alexander Sachs; Brig. Gen. Haig Shekerjian; S. Sobol; Henry L. Stimson (in Columbia University Oral History Collection); N. D. Sturgis; Lt. Gen. Wilhelm D. Styer; Edna Summerfield; Gerold H. Tenney; Hanford Thayer; Brig. Gen. Paul W. Tibbets, Jr. (in Columbia University Oral History Collection); Lt. Col.

James E. Travis; Harry S. Truman; Col. Gerald R. Tyler; Lt. Col. Charles Vanden Bulck; Raymond K. Wakerling; and T. Cortland Williams.

Published Sources

U.S. Government Publications: Primary Materials

In the years since the end of World War II, a substantial amount of primary source material relating to development and employment of atomic energy has become available in publications of federal agencies. The public pronouncements of President Harry S. Truman on atomic energy are conveniently assembled in *Harry S. Truman: Containing the Public Messages, Speeches, and Statements of the President, 1945 and 1946*, Public Papers of the Presidents of the United States (Washington, D.C.: Government Printing Office, 1961–62). Comprehensive coverage of international aspects up to the beginning of 1947 is provided in the Department of State's carefully edited Foreign Relations of the United States, Diplomatic Papers, series. Pertinent are *The Conference of Berlin (The Potsdam Conference), 1945*, 2 vols. (Washington, D.C: Government Printing Office, 1960) and *General: The United Nations*, 1946, Vol. 1 (Washington, D.C: Government Printing Office, 1972). On the preparation of domestic legislation and the question of military versus civilian control, the United States Senate has published its hearings held in late 1945 and early 1946: U.S. Congress, Senate, Special Committee on Atomic Energy, *Atomic Energy: Hearings on S. Res. 179*, 79th Cong., 1st and 2d Sess., 27 November 1945–15 February 1946 (Washington, D.C.: Government Printing Office, 1945–46), and *Atomic Energy: Hearings on S. 1717*, 79th Cong., 2d Sess., 22 January–8 April 1946 (Washington D.C.: Government Printing Office, 1946).

In 1954, the United States Atomic Energy Commission published the transcript of the hearing that its personnel security board conducted into the matter of continuing J. Robert Oppenheimer's security clearance. Besides data on security, the testimony recorded in this transcript, much of it given by participants in the Manhattan Project, provides extensive historical information on many other aspects of the World War II atomic energy program. A detailed record of research in nuclear technology achieved under government contracts during World War II is provided in the multivolumed National Nuclear Energy Series, prepared under the sponsorship of the Manhattan District and its successor civilian agencies, the Atomic Energy Commission, the Energy Research and Development Agency, and the Department of Energy. There are some one hundred volumes in the series, arranged in ten divisions.

The effects of the atomic bombing of Japan are covered in detail in several of the hundreds of reports prepared by the United States Strategic

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Bombing Survey on the effects of aerial attacks in Europe and the Pacific in World War II. These reports are organized into two broad categories, Europe and the Pacific, and numbered consecutively within each category. Four reports within the Pacific category are concerned with the atomic bombing of Japan. Report 3, *The Effects of Atomic Bombs on Hiroshima and Nagasaki,* issued as an unclassified publication in mid-1946, briefly summarizes all aspects in layman's terms. Report 13, *The Effects of Atomic Bombs on Health and Medical Services in Hiroshima and Nagasaki,* also unclassified and published in March 1947, provides detailed data on the medical consequences. Report 92, *The Effects of the Atomic Bomb on Hiroshima,* issued in May 1947, and Report 93, *The Effects of the Atomic Bomb on Nagasaki,* issued in June 1947, each in three volumes, were originally classified secret (subsequently downgraded) and furnish, in great detail, data on the physical effects of the atomic bombings. All of these reports were published by the Government Printing Office in Washington, D.C.

The Manhattan District also issued the results of its own survey, "The Atomic Bombings of Hiroshima and Nagasaki," June 1946, and "Photographs of the Atomic Bombings of Hiroshima and Nagasaki," June 1946.

The official account of Operation Crossroads, the atomic bomb tests conducted by U.S. Joint Task Force One at Bikini Atoll in the Pacific in July 1946, is contained in its historical report *Atomic Bomb Tests Able and Baker (Operation Crossroads),* 3 vols. (Washington, D.C.: U.S. Joint Task Force One, 1947).

U.S. Government Publications: Secondary Accounts

Among the most useful of secondary accounts on the development of atomic energy and related activities in World War II are those in historical series officially sponsored by the U.S. armed forces and by various government agencies. The author found the following especially valuable.

War Department

An indispensable source on the wartime project, and a classic in the literature dealing with the development of atomic energy, is the War Department's official report that was published shortly after the bombings of Hiroshima and Nagasaki in August 1945.

Smyth, H. D. *A General Account of the Development of Methods of Using Atomic Energy for Military Purposes Under the Auspices of the United States Government, 1940–1945.* Washington, D.C.: Government Printing Office, 1945.

In September 1945, Professor Smyth's institution, Princeton University, issued a slightly modified version of this account, with the addition of an index and photographs.

Smyth, H. D. *Atomic Energy for Military Purposes: The Official Report on the Development of the Atomic Bomb Under the Auspices of the United States Government, 1940–1945.* Princeton: Princeton University Press, 1945.

Department of the Army

Each of the following volumes in the U.S. Army in World War II series provides important information on some historical aspect of the wartime Army that related to the Manhattan Project.

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Cline, Ray S. *Washington Command Post: The Operations Division.* Washington, D.C.: Government Printing Office, 1951.

Coll, Blanche D.; Keith, Jean E.; and Rosenthal, Herbert H. *The Corps of Engineers: Troops and Equipment.* Washington, D.C.: Government Printing Office, 1958.

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Fairchild, Byron, and Grossman, Jonathan. *The Army and Industrial Manpower.* Washington, D.C.: Government Printing Office, 1959.

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Green, Constance McLaughlin; Thomson, Harry C.; and Roots, Peter C. *The Ordnance Department: Planning Munitions for War.* Washington, D.C.: Government Printing Office, 1955.

Matloff, Maurice. *Strategic Planning for Coalition Warfare, 1943–1944.* Washington, D.C.: Government Printing Office, 1959.

Millett, John D. *The Organization and Role of the Army Service Forces.* Washington, D.C.: Government Printing Office, 1954.

Palmer, Robert R.; Wiley, Bell I.; and Keast, William R. *The Procurement and Training of Ground Combat Troops.* Washington, D.C.: Government Printing Office, 1948.

Smith, R. Elberton. *The Army and Economic Mobilization.* Washington, D.C.: Government Printing Office, 1959.

Thompson, George Raynor; Harris, Dixie R.; Oakes, Pauline M.; and Terrett, Dulany. *The Signal Corps: The Test.* Washington, D.C.: Government Printing Office, 1957.

Treadwell, Mattie E. *The Women's Army Corps.* Washington, D.C.: Government Printing Office, 1954.

Watson, Mark S. *Chief of Staff: Prewar Plans and Preparations.* Washington, D.C.: Government Printing Office, 1950.

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Armfield, Blanche B. *Organization and Administration in World War II.* Washington, D.C.: Government Printing Office, 1963.

McMinn, John H., and Levin, Max. *Personnel in World War II.* Washington, D.C.: Government Printing Office, 1963.

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World War II. Edited by Kenneth D. A. Allen. Washington, D.C.: Government Printing Office, 1966.

Department of the Navy

In the Navy's semiofficial series History of United States Naval Operations in World War II, the story of the ill-fated *Indianapolis*, which carried atomic bomb parts to Tinian, and the achievement of victory and peace in the Pacific are dealt with in the following volume.

Morison, Samuel Eliot. *Victory in the Pacific, 1945.* Vol. 14. Boston: Little, Brown and Co., 1960.

Army Air Forces

Two volumes in The Army Air Forces in World War II series, edited by Wesley Frank Craven and James Lea Cate, include materials pertinent to that arm's participation in the atomic bombing of Japan.

Europe: Argument to V–E Day, January 1944 to May 1945. Vol. 3. Chicago: University of Chicago Press, 1951.

The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945. Vol. 5. Chicago: University of Chicago Press, 1953.

The special military unit that carried out the atomic bombing of Japan is depicted in the following volume.

509th Pictorial Album: Written and Published by and for the Members of the 509th Composite Group, Tinian, 1945. Edited by Capt. Jerome J. Ossip. Chicago: Rogers Printing Co., 1946.

Office of Scientific Research and Development

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Baxter 3d, James Phinney. *Scientists Against Time.* Boston: Little, Brown and Co., 1946.

Stewart, Irvin. *Organizing Scientific Research for War: The Administrative History of the Office of Scientific Research and Development.* Boston: Little, Brown and Co., 1948.

Thiesmeyer, Lincoln R., and Burchard, John E. *Combat Scientists.* Boston: Little, Brown and Co., 1947.

Department of Energy

Hewlett, Richard G., and Anderson, Oscar E., Jr. *The New World, 1939–1946.* Vol. 1. University Park, Pa.: Pennsylvania State University Press, 1962. This volume, the first in the Department of Energy's history of the former Atomic Energy Commission, comprises a detailed narrative of atomic developments from 1939 through 1946, with emphasis on the scientific aspects.

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National Bureau of Standards

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tional Bureau of Standards, U.S. Department of Commerce, 1966.

Bureau of the Budget

Bureau of the Budget. *The United States at War: Development and Administration of the War Program by the Federal Government.* Washington, D.C.: Committee of Records of War Administration No. 1, War Records Section, Bureau of the Budget, 1946. This is the first of the bureau's historical reports on administration in World War II.

Civilian Production Administration

Civilian Production Administration, Bureau of Demobilization. *Industrial Mobilization for War: History of the War Production Board and Predecessor Agencies, 1940–1945, Program and Administration.* Washington, D.C.: Government Printing Office, 1947. This is the first volume in a projected history of the War Production Board.

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Crowther, J. G., and Whiddington, R. *Science at War.* London: His Majesty's Stationery Office, 1947.

Gowing, Margaret. *Britain and Atomic Energy, 1939–1945.* London: Macmillan and Co., St. Martin's Press, 1964. This volume is the official history of the British wartime atomic energy program.

______, *Independence and Deterrence: Britain and Atomic Energy, 1945–1952.* 2 vols. New York: St. Martin's Press, 1974. This work, written with the assistance of Lorna Arnold, is the continuation of the official history of the British atomic energy program.

Hall, H. Duncan, and Wrigley, C. C. *Studies of Overseas Supply.* History of the Second World War. London: Her Majesty's Stationery Office, 1956. J. D. Scott wrote one of the chapters in this volume.

Japan

The Committee for the Compilation of Materials on Damage Caused by the Atomic Bombs in Hiroshima and Nagasaki, ed. *Hiroshima and Nagasaki: The Physical, Medical, and Social Effects of the Atomic Bombings.* Translated by Eisei Ishikawa and David L. Swain. New York: Basic Books, 1981. This report, commissioned by the cities of Hiroshima and Nagasaki, was compiled by a committee of thirty-four Japanese specialists, with the aim of achieving as definitive an account as possible of the nature and extent of the damage wrought by the atomic bombings of 6 and 9 August 1945.

Office of Civil Defense, Office of the Secretary of War (Japan), and Technical Management Office,

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U.S. Naval Radio. *Analysis of Japanese Nuclear Casualty Data.* Compiled by L. Wayne Davis et al. Albuquerque, N.Mex: Dikewood Corp., April 1966.

Personal Accounts, Memoirs, and Collected Papers

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Bush, Vannevar. *Pieces of the Action.* New York: William Morrow, 1970.

Compton, Arthur Holly, *Atomic Quest: A Personal Narrative.* New York: Oxford University Press, 1956.

Conant, James Bryant. *My Several Lives: Memoirs of a Social Inventor.* New York: Harper and Row, 1970.

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Lilienthal, David E. *The Journals of David E. Lilienthal.* 5 vols. New York: Harper and Row, 1964. Volumes 1 and 2, covering the years from 1939 to 1950, include references pertinent to the Manhattan Project.

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Speer, Albert. *Inside the Third Reich-Memoirs.* Translated from the German by Richard and Clara

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Guide to Archival Collections

To reduce the length of the footnotes, the following abbreviations were used to indicate the specific archival collection for each document cited.

ANL	Records of the Argonne National Laboratory U.S. Department of Energy Lemont, Illinois
ASF	Record Group 160 Records of Headquarters Army Service Forces Records of the Office of the Commanding General, 1941–46 National Archives and Records Service Washington, D.C.
CMH	Records of the Center of Military History Department of the Army Washington, D.C.
DASA	Record Group 374 Records of the Defense Atomic Support Agency National Archives and Records Service Washington, D.C.
DS	Records of the U.S. Department of State Washington, D.C.
FDR	Papers of Franklin D. Roosevelt Franklin D. Roosevelt Library Hyde Park, New York
HLH	Papers of Harry L. Hopkins Franklin D. Roosevelt Library Hyde Park, New York
HLS	Henry L. Stimson Collection Sterling Memorial Library Yale University New Haven, Connecticut
HOO	Records of the Hanford Operations Office U.S. Department of Energy Richland, Washington

JCS	Record Group 218 Records of the United States Joint Chiefs of Staff National Archives and Records Service Washington, D.C.
LASL	Records of the Los Alamos Scientific Laboratory U.S. Department of Energy Los Alamos, New Mexico
LC	Library of Congress Washington, D.C.
LRG	Record Group 200 National Archives Gift Collection Papers of Leslie R. Groves National Archives and Records Service Washington, D.C.
LRL	Records of the Lawrence Radiation Laboratory U.S. Department of Energy Berkeley, California
MDR	Record Group 77 Records of the Office of the Chief of Engineers Records of the Manhattan Engineer District, 1942–48 National Archives and Records Service Washington, D.C.
OCEHD	Records of the Office of the Chief of Engineers, Historical Division U.S. Army Corps of Engineers Washington, D.C.
OCO	Record Group 156 Records of the Office of the Chief of Ordnance National Archives and Records Service Washington, D.C.
OROO	Records of the Oak Ridge Operations Office U.S. Department of Energy Oak Ridge, Tennessee
OSRD	Record Group 227 Records of the Office of Scientific Research and Development National Archives and Records Service Washington, D.C.
SFOO	Records of the San Francisco Operations Office U.S. Department of Energy San Francisco, California

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SHRC	Records of the Albert F. Simpson Historical Research Center Maxwell Air Force Base, Alabama
USS	Record Group 46 Records of the United States Senate National Archives and Records Service Washington, D.C.

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List of Abbreviations

AAF	Army Air Forces
ACS	Assistant Chief of Staff
Act	Acting
Admin	Administrative; Administrator
AEC	Atomic Energy Commission
AEM	Architect-Engineer-Manager
AFL	American Federation of Labor
AFSWP	Armed Forces Special Weapons Project
Agri	Agriculture
ANMB	Army and Navy Munitions Board
Ann(s)	Annex(es)
AR	Army Regulation
ASF	Army Service Forces
Asst(s)	Assistant(s)
ASTP	Army Specialized Training Program
Att	Attachment
Attn	Attention
Atty	Attorney
Bldg	Building
BPA	Bonneville Power Administration
Br	Branch
Budg	Budget
Bull(s)	Bulletin(s)
Bur	Bureau
Cdr	Commander
CDT	Combined Development Trust
CE	Corps of Engineers
Cert(s)	Certificate(s)
CEW	Clinton Engineer Works
CG	Commanding General
CIC	Counterintelligence Corps
CINCAFPAC	Commander in Chief, U.S. Army Forces, Pacific
CINCPOA	Commander in Chief, Pacific Ocean Areas
CIO	Congress of Industrial Organizations
Cir	Circular
Cmd	Command

CO	Commanding Officer
Co	Company
Comm	Commerce
Conf	Conference
Cong	Congress
Constr	Construction
Corp	Corporation
Corresp	Correspondence
CPC	Combined Policy Committee
CPFF	Cost Plus Fixed Fee
CWS	Chemical Warfare Service
DASA	Defense Atomic Support Agency
Def	Defense
Deliv	Delivery
Dep	Deputy
Dept	Department
Det	Detachment
DF	Disposition Form
Diff	Diffusion
Dir	Director
Dist	District
Div	Division
DSM	Development of Substitute Materials
Engr(s)	Engineer(s)
Env	Envelope
Equip	Equipment
ETO	European Theater of Operations
ETOUSA	European Theater of Operations, U.S. Army
Ex	Executive
Fab	Fabrication
FBI	Federal Bureau of Investigation
Fwd	Forward
FY	Fiscal Year
G-1	Personnel
G-2	Intelligence
Gen	General
GO	General Orders
GOCO	Government Owned, Contractor Operated
Govt	Government
Gp	Group
GSC	General Staff Corps

H	House
HB	Harrison-Bundy
HEW	Hanford Engineer Works
Hist	History
HQ	Headquarters
Hwy	Highway
IBM	International Business Machines
ICC	Interstate Commerce Commission
Intel	Intelligence
Incl	Inclosure
Ind	Indorsement
Insp	Inspector; Inspection
Instl(s)	Installation(s)
Instr(s)	Instruction(s)
Interv	Interview
Intro	Introduction
JCS	Joint Chiefs of Staff
JNW	Joint Committee on New Weapons and Equipment
Just	Justice
K-25	Gaseous diffusion project
K-27	Gaseous diffusion extension unit
Lab	Laboratory
LASL	Los Alamos Scientific Laboratory
Ldr	Leader
Ltr	Letter
Mad	Madison
Maint	Maintenance
Man	Managing
Mat	Materials
MD	Manhattan District
Med	Medical
MED	Manhattan Engineer District
Memo	Memorandum
Met	Metallurgical
Mfg	Manufacturing
Mgr	Manager
MID	Military Intelligence Division
Mil	Military
Min	Minutes
MIS	Military Intelligence Service
Misc	Miscellaneous
MIT	Massachusetts Institute of Technology

MP	Manhattan Project; Military Policy; Military Police
MPC	Military Policy Committee
Ms	Manuscript
MSA	Madison Square Area
Mtg	Meeting
Mtn(s)	Mountain(s)
Natl(s)	National(s)
NDRC	National Defense Research Committee
NLRB	National Labor Relations Board
No	Number
NWLB	National War Labor Board
OCE	Office of the Chief of Engineers
OCG	Office of the Commanding General
OCO	Office of the Chief of Ordnance
OCS	Office of the Chief of Staff
ODT	Office of Defense Transportation
OEM	Office of Emergency Management
Off(s)	Officer(s)
OIC	Officer in Charge
OIG	Office of the Inspector General
OPD	Operations Division
OPMG	Office of the Provost Marshal General
Opn(s)	Operations
OQMG	Office of the Quartermaster General
Ord	Ordnance
ORD	Ohio River Division
Org(s)	Organization(s)
OSG	Office of the Surgeon General
OSRD	Office of Scientific Research and Development
OWU	Office of War Utilities
P-9	Heavy Water
PED	Provisional Engineer Detachment
PD	Pacific Division
PR	Press Release
Prelim	Preliminary
Prgm(s)	Program(s)
Prod	Production
Proj(s)	Project(s)
Promo(s)	Promotion(s)
Prov(s)	Provision(s); Provisional
Pub	Public
Rad	Radiation
R & D	Research & Development

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Re	Regarding
Rec(s)	Record(s); Recording
Reg(s)	Regulation(s)
Rels	Relations
Res	Resolution
Rev	Revision; Revised
Rpt(s)	Report(s)
S	Senate
S–1	OSRD's uranium program
S–50	Liquid thermal diffusion project
SCAP	Supreme Commander for the Allied Powers
Scty	Security
Sec	Section
Secy	Secretary
SED	Special Engineer Detachment
Sen	Senator
Ser	Series
Sess	Session
SHAEF	Supreme Headquarters, Allied Expeditionary Force
SMI	Safeguarding Military Information
SOS	Services of Supply
Spec	Special
Sq	Square
Sup	Superseding
Supp	Supplement
Supt	Superintendent
Surg	Surgeon
Svc	Service
SW	Southwest
SWD	Southwestern Division
TA	Tube Alloys
TAG	The Adjutant General
TEC	Tennessee Eastman Corporation
Tech	Technical
Telecon	Telephone conversation
Telg	Telegram
Therm	Thermal
Trans	Transportation
Treas	Treasury
TVA	Tennessee Valley Authority
Und	Under
Univ	University
USASTAF	United States Army Strategic Air Forces
USN	United States Navy

USSBS	United States Strategic Bombing Survey
WAAC	Women's Army Auxiliary Corps
WAC	Women's Army Corps
WD	War Department
WDGS	War Department General Staff
WDSS	War Department Special Staff
West	Western
WMC	War Manpower Commission
WPB	War Production Board
Wpn(s)	Weapon(s)
WW I	World War I
WW II	World War II
X-10	Plutonium project
Y-12	Electromagnetic project
ZI	Zone of Interior

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NEWARK PUBLIC LIBRARY

Index

Aachen, Germany, 288
Abelson, Philip H., 36, 172–76, 180
Acheson, Dean, 573
Acheson-Lilienthal report, 574
Ackart, E. G., 199
Adams County, Wash., 110, 332
Adamson, Lt. Col. Keith F., 19–22, 24
Adelman, Arthur, 20
Adler, Edward, 154–57
Advisory Committee on Nuclear Research, 26–27
Advisory Committee on Research and Development, 589–91
Advisory Committee on Uranium, 21–23, 26. *See also* Office of Scientific Research and Development, S–1 Executive Committee *and* S–1 Section; Uranium, Committee on; Uranium, Section on.
African Metals Corporation, 65, 79, 300–301, 304, 308, 310. *See also* Union Miniere du Haut Katanga.
Agreement and Declaration of Trust, 297–98, 301*n*, 304, 572
Air Engineering Squadron, 603d, 521
Air Force
  Eighth, 288
  Twentieth, 523, 528, 530
Air Service Group, 390th, 521
Air Transport Command, 217, 408–09
Akers, Wallace A., 99, 229–33, 237, 245
Alabama Ordnance Works, 108, 191, 343
Alamogordo Army Air Field, N.Mex., 478, 507, 511, 517. *See also* Project Trinity, bomb test.
Albuquerque District, 84–85, 466, 468–69, 486
Allis-Chalmers Manufacturing Company
  electromagnetic project, 130, 133, 136–37
  gaseous diffusion plant, 158, 160
  unionized, 371
Allison, Samuel K., 488
Alma Trailers, 437
Alpha racetracks, 120, 128–29, 132, 134–39, 142, 144, 580
ALSOS mission
  in Italy, 281–82
  in London, 282–84
  organization of, 280–8
  in Western Europe, 285–91
Amberg, Julius M., 337, 340
American atomic energy program. *See* Manhattan Project.
American Cynamid, 314
American Federation of Labor, 351, 370–71
American Industrial Transit, Inc., 446
American Red Cross, 428, 443
Anacostia Station, D.C., 173
Anchor Ranch Proving Ground, N.Mex., 506–07
Anderson, Herbert L., 8*n*
Anderson, Sir John
  agreements with French scientists, 249–52
  Anglo-American collaboration, 228–29, 235, 237, 239, 244, 248, 561, 571
  control of Congo ore deposits, 297–98, 300
  thorium supplies, 305
Anderson County, Tenn., 70, 78, 320, 326, 403
Anglo-American collaboration
  achievement of in 1940–41, 29, 31
  breakdown of in 1942, 227–32
  Combined Policy Committee, 239, 241–43, 245–47, 252
  French repatriated scientists, 248–52
  new negotiations in 1943, 232–40
  postwar planning, 564–67, 570–73
  Quebec Agreement, 241–42, 245, 247, 249
  and security, 230
Applied Physics Laboratory, 508
Argonne Forest, Ill., 47, 67–68, 71–72, 96, 111–14, 185, 194, 221, 247
Argonne Laboratory, 113, 200, 342, 350, 385, 590. *See also* Metallurgical Project.
Argonne National Laboratory, 590
Aristotle, 3
Armed Forces Special Weapons Project, 600*n*
Army Air Forces, 490, 495, 519–23
Army Command Administrative Network, 395
Army Groups
  6th, 287–88, 290
  12th, 288
  20th, 288
Army and Navy Munitions Board, 57–61, 67, 81
Army Service Forces, 116, 208*n*, 358, 365. *See also* Services of Supply.
Army Specialized Training Program, 358, 497
Arneson, 1st Lt. R. Gordon, 555
Arnold, General Henry H., 519–21, 523, 528–29
Arnold, Samuel T., 350, 492
Ashbridge, Lt. Col. Whitney
  Los Alamos construction, 469, 475, 477
  Los Alamos post commander, 425, 487, 497–98, 500–501
Ashworth, Comdr. Frederick L., 524, 529, 540–42
Associated Press (Albuquerque), 514, 517

Associated Universities, Inc., 590–91
Atchison, Topeka and Santa Fe Railroad, 397, 478
Atkinson, Guy F., Company, 406
Atlee, Clement, 570, 572–73
Atomic bombing of Japan
  AAF role in, 519–23
  American casualties in, 547
  overseas bases for, 523–28
  preparations for, 519–23, 534–36
  Senate hearings on, 548–50
  target choices for, 528–30
  USASTAF directive for, 534
Atomic communities. *See* Clinton Engineer Works; Hanford Engineer Works; Los Alamos Laboratory.
Atomic energy
  international control of, 569–74
  postwar legislation, 574–78
  postwar planning, 562–68
Atomic Energy Act of 1946, 578, 596, 598–99
Atomic Energy Commission. *See* United States Atomic Energy Commission.
Atomic fission
  concept, historical evolution of, 3–8
  military application of, 11–12
  and uranium, 8–11
Auger, Pierre, 249–50, 252
Aurand, Maj. Gen. Henry S., 597
Austin, Warren R., 577

B-29's, 510*n*, 520–23, 528
Bacher, Robert F., 574, 589, 597–98
Bacon, Francis, 3
Badger, E. B., and Sons, 49, 58
Badoglio, Marshal Pietro, 281
Bainbridge, Kenneth, 478, 515
Bakelite Corporation, 151, 155, 160. *See also* Union Carbide and Carbon Corporation.
Ballistic Research Laboratory, 487
Bandelier National Monument, N.Mex., 469
Bankers Trust Company, 302
Bard, Ralph A., 530
Barker, Maj. Maurice E., 20
Barkley, Alben W., 272
Barnard, Chester I., 574
Barnes, Sir Thomas, 297
Barnes, W. L. Gorell, 298
Barrier R & D, 154–57
Baruch, Bernard M., 573–74
Bateman, George C., 299
Batista Field, Cuba, 523
Baxter, John P., 145
Baxter, Capt. Samuel S., 435–37, 443
Bayway, N.J., 133
Beams, Jesse W., 10, 36
Bear Creek Valley, Tenn., 130
Becquerel, Henri, 4
Belgian Agreement. *See* Tripartite Agreement.
Belgian Congo and uranium ore, 8, 14, 24–25, 79–80, 292, 295–96, 310, 312
Bell, Daniel W., 67
Bell Telephone Laboratories, 151, 155
Benbow, Maj. Horace S., 247
Benton County, Wash., 110, 332, 451
Beta racetracks, 128–29, 132, 135, 139, 142, 580
Bethel Valley, Tenn., 204, 206
Bethlehem Steel Corporation, 160
Betts, Brig. Gen. Edward C., 297–98
Beverly Junction, Wash., 405, 408*n*
Biddle, Francis, 338, 340–41
Bikini Atoll tests. *See* Operation CROSSROADS.
Bissell, Maj. Gen. Clayton L., 285
Bissingen, Germany, 287, 290
Black Oak Ridge, Tenn., 78–79, 320*n*, 433–34, 443
Black oxide, processing of, 310–12, 314–16
Blair, A. Farnell, 437
Blair, Lt. Col. Robert C., 443
Blair Road, CEW, 403–04
Bloch, Capt. Edward J., 438
Blok, Arthur, 248
Bock's Car (B-29), 540–41
Bohemian Grove, Muir Woods, Calif., 70–72, 74, 79, 96
Bohr, Niels, 4, 7, 13, 564
Bomb components stockpile, postwar, 581*n*, 593–94
Bomb models, 508
Bombardment Squadron (VH), 393d, 521–23
Bombardment Wing, 313th, 526
Bomber Command, XXI, 526
Bonnet, Maj. William A., 137
Bonneville Dam, Wash., 110, 392
Bonneville Power Administration, 69, 110, 378–81, 387–88, 391–94
Bowen, Rear Adm. Harold G., 24, 26
Boyd, George E., 318
Boyle, Robert, 3
Bradbury, Comdr. Norris, 582
Brazier, B. E., 476
Breeder reactor, 583
Brereton, Lt. Gen. Lewis H., 598
Brewster, Owen, 335*n*
Bridges, Styles, 273
Briggs, Lyman J.
  development of atomic energy program, 21–24, 26–27, 34, 38, 44
  liquid thermal diffusion process, 173–75
Brindisi, Italy, 281
British atomic project. *See* Tube Alloys.
British Mission to Japan, 545
British scientists
  electromagnetic research, 124–25, 147
  gaseous diffusion process, 10, 29–30, 35, 153, 155–56, 230–31
  interchange policy, 271, 304
Brookhaven National Laboratory, 591–92
Brown, Edward J., 354
Brown oxide, processing of, 315–16
Brown University, 119*n*

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Bruce, E. L., 437
Bruns General Hospital (Santa Fe), 425
Brush Beryllium Company, 313
Building and Construction Trades Department, AFL, 351, 370–71
Bundy, Harvey, 46, 60, 77, 242, 298, 337, 349, 513
  Anglo-American collaboration, 228, 237, 240, 248, 251–52
  postwar planning, 560, 567–68
Bureau of Mines, 313, 427
Bureau of Ordnance (Navy), 495, 501, 505
Bush, Lt. Harold C., 480–81
Bush, Vannevar, 47, 53–54, 56, 174, 285, 335
  Anglo-American collaboration, 227–31, 234–40, 248, 250, 296
  Army control of atomic program, 73–74, 76–77
  bombing of Japan, 514, 516, 530
  Combined Policy Committee, 241–43, 246
  development of atomic program, 30–35, 37–39
  establishment of Manhattan District, 40, 44, 46
  Los Alamos program, 87, 494
  Military Policy Committee, 77, 227, 335, 494, 589
  NDRC and OSRD, 26–28, 30–31
  postwar planning, 556, 563, 565–71, 573–75
  priority ratings, 59–61
  scientific personnel procurement, 345, 349
  security system for Manhattan District, 261, 273, 277
  Top Policy Group, 31, 34, 73
Byrd, Harry F., 336, 577
Byrnes, James F., 374, 530, 533, 570–71, 573

C–54's, 527, 536
California Institute of Technology, 499, 501, 510
Calutrons, 119–20, 122, 132–33, 136
Calvert, Maj. Horace K., 256, 258, 282, 286
Campbell, Sir Ronald I., 305
Canada
  joint control of Congo ore, 296, 298
  ore resources, 25, 299, 310–12, 314
Canadian atomic project. *See* Evergreen.
Canadian Radium and Uranium Corporation, 62, 79, 312
Cannon, Clarence, 274
Cantril, Simeon T., 411*n*, 415
Carbide and Carbon Chemicals Corporation
  barrier fabrication, 151, 156
  labor activities at, 372, 374, 376
  operation of gaseous diffusion plant, 106, 165–67, 170, 398, 418, 593
  See also Union Carbide and Carbon Corporation.
Carnegie Institution, 8, 24, 36, 173, 487
Carnotite ores, 311, 314
Carpenter, Walter S., Jr., 98–99, 337
Carteret, N.J., 133
Casablanca meeting, 233–34
Cascade design, single, 152–53, 155–59, 169
Celle, Germany, 289
Censorship, 277–79
Centrifuge process, 10, 23, 47, 50–51, 71, 149*n*
Chadwick, Sir James, 5–6, 8*n*, 100, 514
  Combined Policy Committee, 242*n*, 243–47
  postwar planning, 560–61, 572
Chain reaction, 7–10
  pile process, 51–52, 102–04, 190–91
  uranium-graphite system, 11, 21, 23, 28
Chalk River, Ontario, 246–47
Chambers Chemical and Dye Works, 202, 315. *See also* Du Pont, E. I., de Nemours and Company.
Chemical Warfare Service, 20, 132
Cherwell, Lord (Frederick Lindemann), 235–37, 533, 566
Chevalier, Haakon, 264
Chicago, Milwaukee, St. Paul and Pacific Railroad, 332, 405–08, 451
Chrysler Corporation, 160, 166, 371
Churchill, Winston S., 31–32, 298, 518, 533
  Anglo-American collaboration, 228, 233–39
  postwar planning, 564–66
  Quebec Agreement, 240–42
Clark, Joseph P., 374
Clarke, Col. Frederick J., 584*n*
Clay, Brig. Gen. Lucius D., 57–60, 433–34
Clayton, William L., 530
Clifton Products, Inc., 594–95
Clinch River, Tenn., 47, 71, 78, 160–61, 320*n*, 390, 433, 442
Clinton, Tenn., 78, 179, 204, 326, 433
Clinton Engineer Works, 78–79, 91, 128, 576, 590
  Army–Du Pont cooperation at, 206
  atomic communities, 432–48
  communications and transportation at, 394–99, 401–05, 408
  electrical power for, 380–82, 386, 388–91
  health program at, 415–16, 418–19, 421–24
  labor shortage at, 351–54
  labor relations at, 372–74
  labor turnover and absenteeism at, 363–66
  land acquisition for, 322–28
  plant construction at, 130, 134–40, 159–65, 179–80, 205–08, 580–81, 585, 593
  plant operation at, 140–48, 165–71, 180–83, 208–10
  safety program at, 427–30
  site selection for, 78–79, 435–40
  work stoppages at, 370–71, 375–76
Clinton Home Building, 437
Clinton Laboratories, 200, 350, 544
  construction of, 204–08
  medical research at, 415
  operation of, 208–10, 583, 591, 594
  See also Metallurgical Project.
Cockcroft, Sir John D., 5–6, 246–47
"Codes of Wartime Practices for the American Press and American Broadcasters," 277
Cohen, Karl P., 150, 152, 177
Collins, Lt. Col. John K., 352–53, 365
Colorado Plateau, 8, 80, 311–12, 314

Columbia River, Wash., 110-11, 210, 212, 215, 332, 405, 450, 455-56, 460, 478
Columbia University, 27-28, 415
  barrier fabrication, 154-57
  gaseous diffusion research, 105, 149-50, 153-54, 159
Combined Development Trust, 90*n*, 571, 599
  foreign ore acquisition, 286, 302-06, 573
  joint control of Congo ore, 298-301
  legality of, 297-98
Combined Policy Committee, 90*n*, 239, 241-43, 245-47, 252
  Anglo-American cooperation, 571-73
  foreign ore acquisition, 296, 299-300, 303, 572-73
  patent problems, 247-48
  technical subcommittee on interchange, 242-47
Communications, 394-97
Community management
  at Hanford and Richland, 460-64
  at Los Alamos, 474-77
  at Oak Ridge, 443-48
Compartmentalization policy, 410
  and Congress, 272-74
  at Los Alamos Laboratory, 491, 495
  for safeguarding military information, 268-72
Composite Group, 509th, 521-24, 526-28, 534, 536, 538
Compton, Arthur H., 44, 62, 271, 275, 350, 509, 583*n*
  chain reaction, 102-03
  development of atomic energy program, 30, 34, 36, 38
  establishment of Los Alamos, 83-84, 86-87
  interchange arrangements with British, 243, 246
  pile process, 185, 190, 194-97, 221
  plutonium project, 47, 51-52, 95-101, 199-200
  plutonium semiworks, 111-14, 208
  postwar planning, 556, 563, 574, 589
Compton, Karl T., 530-33
Conant, James B., 28, 118, 261, 284, 350
  Anglo-American collaboration, 227, 230-35, 239-40
  Army control of atomic program, 73, 77
  bomb development, 503, 506-07, 509-10, 513-14, 516
  Combined Policy Committee, 241-42, 244, 246
  establishment of Los Alamos, 83, 86-87, 467
  establishment of Manhattan District, 44-45
  Interim Committee, 530, 532
  isotope separation processes, 36-39
  liquid thermal diffusion process, 174, 177
  Los Alamos weapon program, 486, 490, 494, 496, 501
  plutonium project, 97-101, 114
  postwar planning, 563, 565-67, 569, 573-76
  priority ratings, 58-59, 61
  Smyth *Report*, 556, 558, 560-61
  Top Policy Group, 31, 33-34
Condon, Edward U., 271, 492, 577
Conklin, Frederick R., 146
Connally, Tom, 577
Consodine, Lt. Col. William A., 298, 555
Consolidated Mining and Smelting Company, 47, 49, 581
Contractor policies, 275-76, 370-71, 417-18, 428, 461
Contractor war claims, 594-95
Cook, Walter W., 476
Cook County Forest Preserve, Ill., 47, 68
Coolants, 190-93, 212, 215
Copper, 61, 66
Cornelius, Maj. William P., 161
Cornell University, 27, 590
Corps of Engineers. *See* Engineers, Corps of.
Counterintelligence Corps Detachment, 256, 260-68, 272
Counterintelligence operations, 255-57, 259-63
Craig, General Malin, 519*n*
Creedon, Frank R., 137
Crenshaw, Lt. Col. Thomas T., 53, 64, 71, 118, 307-08, 317-18, 437
Cyclotrons, 35, 52, 86, 119, 122, 583
Cyclotrons, destruction of Japanese, 585-88

Dahlgren, Va., 508
Dale Hollow Dam and Reservoir, Tenn., 320
Dalton, John, 3
Davalos, Capt. Samuel P., 478, 500
Davis, Clifford C., 325
Davis, Laurence W., 354
Day, H. J., 201
Decatur, Ill., 370-71, 376
Declaration of Trust. *See* Agreement and Declaration of Trust.
Deep Water, N.J., 202, 315
Defense Plant Corporation, 133
Delimitations Agreement, 255
Dennison, David M., 528
Department of Agriculture, 27, 324, 329
Department of Interior, 380
Department of Justice, 322, 325, 333, 336-38, 341-42
Department of Labor, 427
Department of State, 568, 571, 573, 575, 599
Department of the Treasury, 67, 301
Derry, Maj. John A., 520, 528
Descartes, Rene, 3
Desert training area (Army), near Rue, Calif., 478*n*
de Seversky, Maj. Alexander, 545, 548-50
de Silva, Lt. Col. Peer, 527
Diebner, Kurt, 290
Dill, Field Marshal Sir John, 241-43
Division of Military Application, AEC, 598
Doan, Richard L., 318
Donner Laboratory, 118, 122. *See also* University of California (Berkeley).
DSM (Development of Substitute Materials) project, 43-44, 67, 71

NEWARK PUBLIC LIBRARY

Dudley, Maj. John H., 84, 328
Dunning, John R., 8*n*, 10, 30, 51, 150
Du Pont, E. I., de Nemours and Company, 64, 104, 154, 371
  Chambers Chemical and Dye Works, 202, 315
  Clinton Engineer Works
    semiworks construction at, 204–08
    Oak Ridge housing at, 441–42
  Engineering Department, 199, 206
  feed materials production, 314–17
  Hanford Engineer Works
    Army collaboration at, 202–04
    community construction at, 452–59
    community management at, 460–63
    plant construction at, 211–18, 352, 354
    plant operation at, 219–22, 391–92, 591–93
    safety and health programs at, 413, 420, 424, 428
    site selection for, 109–10, 450–51
    transportation and communications at, 395–96, 398–99, 401*n*, 403, 406–07
  Metallurgical Laboratory collaboration, 194–97, 452, 454
  Metallurgical Project collaboration, 203–04
  plutonium project, 96–99, 101, 105–06, 108–12, 114, 190–94, 198–99, 210
  TNX Division, 113, 198–99, 202–03, 210, 217
Durand and Sons, A. A., 454–455

East Fork Valley, Tenn., 434
Eastman, Joseph T., 408
Eastman Kodak Laboratories, 119*n*
East Town, CEW, 435–36, 439, 443
East Village, CEW, 436, 439, 458
Echols, Maj. Gen. Oliver P., 520
Eden, Anthony, 235
Einstein, Albert, 6, 13–14, 21, 23
Eisenhower, General Dwight D., 284, 297, 584
Eldorado Gold Mines, Ltd., 8, 25, 62, 64, 79–80, 296*n*, 311
Eldorado Mining and Refining Company, 308, 310–311, 313–14
Electric power, 377, 393
  contracts and agreements for, 386–88
  distribution of
    at Clinton Engineer Works, 388–91
    at Hanford Engineer Works, 391–93
  requirements and sources of, 377–82, 385, 388
Electromagnetic (Y–12) process, 10, 34–35, 37, 71, 104–05, 117–18, 176–77
  Army administration, 118–26
  construction procurement, 130–33
  failure of great magnets, 266–67
  hazards control program, 418–19
  plant construction, 130, 134–40
  plant design and engineering, 126–29
  plant operation, 140–48, 580
  research and development, 50–53, 119–20
Electromagnetic (Y–12) process—Continued
  War Department contracts, 120–23, 126, 134, 140, 145
Electro Metallurgical Company, 64, 310, 316–17
Elliott Company, 154
Engel, Albert J., 273–74
Engineer Combat Battalion, 1269th (less Company B), 290
Engineers, Corps of, 40–41, 89
Engineers offices
  Beverly Area, 308, 310
  Boston Area, 127, 130, 434
  California Area, 53, 64, 118
  Chicago Area, 68, 185–87, 201–02
  Clinton Area, 200–201, 346, 368, 395–96
  Colorado Area, 308
  Hanford Area, 200–201, 457, 463
  Iowa Area, 308, 310
  Los Angeles Area, 499
  Madison Square Area, 91, 143, 308, 312–14, 316–18, 416, 595
  Murray Hill Area, 294–95, 308
  New York Area, 91, 133, 151, 160, 166
  Santa Fe Area, 466
  St. Louis Area, 308, 310
  Tonawanda Area, 308, 310
  Wilmington Area, 201–02, 308, 310
Enlisted Reserve Corps, 354, 359
Enola Gay (B–29), 536–37
Espionage. *See* Security.
Espionage Act, 261, 577
Ether process, 62
European Theater of Operations, 280
Evans, R. Monte, 199
Evans, Maj. Thomas J., Jr., 178
Evergreen (code name for Canadian atomic project), 246–47
Expert Tool and Die Company, 508

Farm Security Administration, 323
Farrell, Brig. Gen. Thomas F.
  bombing of Japan, 528, 534–35, 538, 540, 542–44, 549
  problems at CEW, 147–48
  Project Trinity preparations, 511–12, 514–16
"Fat Man," 508, 522, 527, 536, 538, 540–41
Federal Bureau of Investigation, 255
Federal Prison Industries, 334
Federation of Architects, Engineers, Chemists, and Technicians (CIO), 264
Federation of Atomic Scientists, 577
Feed materials program
  organization of, 307–10
  procurement for, 310–14
  production of, 314–17
  quality control, 317–18
Feis, Herbert, 65
Felbeck, George T., 165

- Fercleve Corporation, 180–83, 374, 418
- Ferguson, H. K., Company, 178–80
- Fermi, Enrico, 113, 531
  - atomic energy research, 6–7, 8*n*, 9–12, 21–24, 30
  - bomb development, 488, 503*n*, 509
  - chain reaction, 21, 23, 102–04
  - pile process, 184*n*, 190–92, 194, 221
- Ferry, Capt. John L., 416
- Fidler, Capt. Harold A., 118, 122–23, 125–26
- Field Artillery Armory, 124th, 186
- Fifth Army, 281
- Fine, Paul C., 558
- Finletter, Thomas K., 65
- First War Powers Act of 1941, 430
- Fisher, Col. William P., 528
- Flaherty, Lt. (jg.) John J., 374
- Fontana Dam, N.C., 381
- Ford, Bacon, and Davis, 161, 163, 166, 442
- Foreign intelligence operations. *See* Alsos mission.
- Fort Loudoun Dam, Tenn., 390–91
- Foster and Creighton, 437
- Fox, Lt. Col. Mark C., 137, 178, 180
- Franck, James, 272, 532–33
- Franck report, 532–33
- Franklin County, Wash., 110, 332
- Franklin Institute, 415
- Frazier, Brig. Gen. Thomas A., 279
- French repatriated scientists, 248–52
- Friedell, Lt. Col. Hymer L., 411–12, 415, 544
- Frijoles Canyon, N.Mex., 469
- Frijoles Lodge (near Los Alamos), 469
- Frisch, Otto R., 7, 290
- Fuchs, Klaus, 266
- Fukushima, Japan, 528
- Fuller Lodge (Los Alamos), 471
- Funding
  - for Combined Development Trust, 301–02
  - for electromagnetic process, 121–23
  - for Manhattan Project, 49–50, 56–57, 115–16, 272–74, 590
  - for NDRC–OSRD program, 22, 24–25, 38–39
- Furman, Maj. Robert R., 282, 286, 536, 544
- Fusion bomb development, 503*n*

- Gable Mountain, Wash., 111, 331*n*
- Galileo, 3
- Gallaher Bridge Road, Tenn., 403–04
- Gamble Valley, CEW, 441
- Gary, Tom C., 101
- Gaseous diffusion (K-25) process, 149–51, 171
  - Army administration, 149–50
  - extension plant (K-27), 390–91, 581, 593
  - plant construction, 159–65
  - plant design, 152–59
  - plant operation, 165–71, 580–81, 593
  - research and development
    - barrier, 154–57
    - by British scientists, 10, 29–30, 35, 153, 155–56, 230–31
- Gaseous diffusion (K-25) process—Continued
  - research and development—Continued
    - at Columbia and Kellex, 10, 34, 36, 38, 101, 104, 149–50, 153–55, 157, 159
- General Advisory Committee, AEC, 578
- General American Transportation Company, 313
- General Chemical, 314
- General Electric Company, 129–30, 592
- George, Lt. Col. Warren, 132, 135
- Gerlach, Walther, 290
- Germany
  - Alsos missions against, 280–82, 285–91
  - Groves's concern about, 509*n*
  - intelligence information on, 253
  - interest in heavy water, 23, 66
  - interest in nuclear research, 12–14, 23–24, 27, 253, 280
  - special intelligence activities against, 282–85
  - U.S. race with, 35–39
- Giles, Lt. Gen. Barney McK., 524
- Giroux, Carl H., 110, 380, 382
- GOCO plants, 370, 373–74
- Goettingen, Germany, 289
- Goldschmidt, Bertrand, 249–50
- Goudsmit, Samuel A., 285–86, 290
- Grafton, Capt. James F., 68, 186, 201
- Graham's Law, 152
- Grand Coulee Dam, Wash., 110, 379*n*, 381, 392
- Grand Junction, Colo., 308, 595
- Grant County, Wash., 110, 332
- Graves, George, 199
- Great Bear Lake, Canada, 8, 311–12
- Great Britain
  - proposed international control measures, 564–67, 570–73
  - raw materials acquisition, 295–96, 303–06
  - *See also* British scientists; Anglo-American collaboration.
- Great Northern Railroad, 407
- Great Sand Dunes National Monument, Colo., 478*n*
- Green, William, 373
- Green salt, processing of, 315–16
- Greenewalt, Crawford H.
  - pile process, 195, 199, 203–05, 221–22
  - plutonium project, 100–101, 104, 112
- Greenglass, David, 266
- Gross, Maj. Gen. Charles P., 80
- Groves, Maj. Gen. Leslie R., 41, 55, 74*n*, 79, 103, 427
  - Alsos mission, 280–89, 291
  - Anglo-American collaboration, 227, 229–31, 233, 240
  - bombing of Japan, 519–21, 523–24, 526–27, 533–34, 537*n*, 538, 541–43
  - bombing targets, 528–30, 532
  - CEW community development, 433–34, 443–44
  - communications and transportation systems, 396, 403–04, 407–08
  - contract negotiations, 105–07, 166, 443–44, 591–92
  - destruction of Japanese cyclotrons, 587–88

NEWARK PUBLIC LIBRARY

Groves, Maj. Gen. Leslie R.—Continued
  development of the bomb, 503–04, 506–07, 509–10
  electric power procurement, 377, 380–83, 385, 387
  electromagnetic process, 118, 125–26, 128–29, 134–36, 138, 145–46
  establishment of Los Alamos, 83–87
  French repatriated scientists, 249–52
  gaseous diffusion plant, 155–57, 159, 165, 171
  health programs, 411, 420–21
  HEW community development, 453, 455, 457, 461–62
  interchange with British, 243–47
  liquid thermal diffusion process, 174–78, 180–81
  Los Alamos Laboratory administration, 485–86, 489–92, 494–96, 499–501
  Los Alamos community, 467, 469, 475
  Manhattan Project, organization and funding of, 73–77, 89–90, 115, 588–90
  manpower conservation, 364, 370, 372–74, 376
  manpower procurement, 347–54, 356, 358, 361–62
  Oppenheimer security clearance, 261–62
  ore exploration and joint control of, 293, 296, 298–306
  pile process, 188–91, 194, 196–97
  plutonium project organization, 96–101
  plutonium production, 198, 202–03, 206, 208, 210, 220–23
  postwar policy planning, 563, 569, 571–75, 577
  press releases, 554–55
  priority ratings, 61, 81–82
  production operations, postwar, 579–82, 584, 591–95
  Project Trinity, 511–17
  security systems, 256–58, 260, 263–64, 266–68, 270–72, 274, 277–78
  site selection, 47, 69–70, 78–79, 83–88, 108–11, 434
  Smyth *Report*, 556–61
  transfer of Manhattan Project to AEC, 597–601
Guam, 524, 534, 538
Guarin, Maj. Paul L., 294, 304–05
Gueron, Jules, 249–50
Gun-assembly method, 489
Gun-type bomb, 504–06, 508–10, 520
Gunn, Ross, 12, 27–28, 172–73
Gunnison Housing, 437

Hadden, Gavin, 341
Hahn, Otto, 7, 8*n*, 13, 290
Haigerloch, Germany, 290
Halifax, Lord, 572
Ham, Maj. R. C., 282
Hambro, Sir Charles J., 299–300
Hamilton, J. D., 121*n*
Hamilton Field, Calif., 536, 544
Handy, General Thomas T., 537*n*, 541
Hanford, Wash., 110, 114–15, 211, 332, 339–41, 391–92, 450–51, 453, 460–62
Hanford Engineer Works, 91, 267, 274, 278
  Army-Du Pont administration of, 202–04, 210–12, 214, 216–17
  atomic communities, 450–64
  communications and transportation at, 394, 396–99, 401–02, 404–09
  electrical power for, 381–82, 387–88, 391–93
  health program at, 420, 424
  labor shortage at, 214, 216, 218, 351–54
  labor turnover and absenteeism at, 363–66, 370
  land acquisition for, 331–41
  plant construction at, 210–18
  plant operation at, 219–23, 580–81, 585, 592–93
  safety program at, 428–29
  work stoppages and union activities at, 370, 375
Happy Valley, CEW, 442
Harman, Col. John M., 86–87, 328–29, 486–87, 497
Harmon, Lt. Gen. Millard F., 524
Harriman, Tenn., 320
Harrington, Willis, 98
Harrison, Brig. Gen. Eugene L., 290
Harrison, George L., 251, 299, 302
  bombing of Japan, 513, 517, 530, 533
  postwar planning, 560–61, 568–69, 571
Harshaw Chemical Company, 168, 310, 314, 316
Hart, Thomas C., 577
Harvard University, 27, 590
Hawkins, David, 494*n*
Health program, 410–12
  clinical medicine services, 420–26
  industrial medicine research, 416–20
  medical research, 414–16
  organization of, 412–14
Heavy water (P–9), 11, 23, 29, 34–35, 51
  British interchange on, 229, 231, 235
  and Canadian project, 246–47
  as a coolant, 190–91
  production of, 58–59, 61, 66–67, 72
  research, 196–97
Hechingen, Germany, 287, 290
Heisenberg, Werner, 8*n*, 290–91
Helium, 312–13
Hempelman, Louis H., 416–17
Hercules Powder Company, 508
Hernandez, Clinton N., 446
Hickenlooper, Bourke B., 577
Hilberry, Norman, 98, 103, 113–14, 200, 222
Hill, Capt. Thomas B., 526
Hirohito, Emperor, 542
Hiroshima, Japan, 537–38
  bombing of, 537–38
  survey teams at, 544–45, 548
Hitler, Adolf, 280
Hoberg, Maj. Henry G., 446
Hodgson, Lt. Col. John S., 137, 139, 447
Holmes, Hal, 336
Hooker Electrochemical Company, 166, 310, 314, 371

Hooper, Rear Adm. Stanford C., 12
Hoover Dam, Ariz., 110
Hoover, Comdr. Gilbert C., 20–22, 24
Hopkins, Harry, 233–37
Horb, Germany, 290
Houdaille-Hershey Corporation, 156–57, 160, 371
Hough, Maj. Benjamin K., Jr., 127, 150
House committees. *See* U.S. Congress, House of Representatives.
Housing
  at Clinton Engineer Works, 435–42
  at Hanford Engineer Works, 455, 457–60, 462
  at Los Alamos, 468–71, 475, 477
Howard, Nathaniel R., 278
Howe, Clarence D., 241–42
Hubbard, Jack M., 515
Huffman, J. R., 247
Hughes, Arthur L., 492
Hull, Cordell, 297
Hull, Lt. Gen. John E., 519*n*
Hutchins, Robert Maynard, 115
Hyde Park
  aide-memoire, 565–66, 570
  summit meetings, 227–28, 241, 564–65

Implosion bomb, 489, 504, 506–10, 512, 516–17, 519-21
Imrie, Capt. Mathew, 476
Indianapolis, 536
Industrial hazards, 416–19
Industrial Personnel Division, ASF, 348, 351
Institute for Physical and Chemical Research, Tokyo, 586
Insurance program, 430–31
Interchange, Anglo-American. *See* Anglo-American collaboration.
Interchemical Corporation, 151
Interim Committee
  composition and function of, 530–33
  postwar legislation on atomic energy, 90*n,* 568, 574, 576
  press releases, 538, 554–56
  scientific panel, 531–33, 576
International Association of Chiefs of Police, 428
International Association of Machinists, 374
International Association of Plumbers and Pipe Fitters, 354
International Brotherhood of Electrical Workers, 372, 374
International Brotherhood of Firemen and Oilers, 372, 374
International Brotherhood of Teamsters, 459
International Nickel Company, 154*n,* 156
Interstate Commerce Commission, 407, 459
Interstate Roofing Company, 160
Inyokern, Calif., 507
Iowa State College, 27, 64, 193, 316–18, 343, 487, 505
Ismay, Lt. Gen. Sir Hastings L., 284
Isotopes, 5, 8–11, 23, 28–29, 32–33
Iwo Jima, 526, 535–36

Japan
  bombing of Hiroshima, 537–38
  bombing of Nagasaki, 538
  surrender of, 541–42
  See also Atomic bombing of Japan.
Jeffers, William, 407
Jemez Mountains, N.Mex., 328, 465
Jemez Springs, N.Mex., 84
Jennings, John, Jr., 324–26
Joachimsthal (Jachymov), Czechoslovakia, 283
Johns Hopkins University, 8, 27, 119*n*, 126, 145, 314, 590
Johnson, Capt. Allan C., 61, 380–81, 385, 434
Johnson, Edwin C., 575*n*, 576, 595
Johnson, Herschel V., 305
Johnson, John A., 437
Joint Chiefs of Staff, 82, 586–87
Joint Commission for the Investigation of the Atomic Bombing of Japan, SCAP, 545
Joint Committee on New Weapons and Equipment, JCS, 39, 44, 73, 77
Joliot-Curie, Frederic, 8*n*, 12, 66, 249–50, 252, 286
Jones, J. A., Construction Company
  gaseous diffusion plant, 106–07, 160–61, 163–65, 167, 383, 398, 404
  Oak Ridge community, 442–43
Jones, Couillan, Thery, and Sylliassen, 454
Jornada del Muerto valley, N.Mex., 465, 478, 516
"Jumbo," 508*n*, 512

k factor, 190–92
Kadlec, Lt. Col. H. R., 203
Kaiser Wilhelm Institute, Berlin, Germany, 12, 287–88
Kapitza, Peter, 564*n*
Keith, Percival C.
  Anglo-American collaboration, 233, 243
  gaseous diffusion plant, 151, 156, 165, 170–71
Kellex Corporation
  barrier R & D, 154–57
  gaseous diffusion plant
    design of, 106, 150–51, 153, 158–59, 170, 383
    construction of, 160–63, 165–66
Kelley, Maj. Wilbur E., 132, 141, 146–47
Kellogg, M. W., Company, 49, 51, 102, 106, 150–51
Kelly, Joseph A., 312–13
Kennewick, Wash., 456, 460
Kinetic Chemicals, 314
King, Admiral Ernest J., 526, 534
King, William Lyon Mackenzie, 235, 570
Kingston, Tenn., 78, 326
Kingston Demolition Range (Clinton Engineer Works), 78, 319

NEWARK PUBLIC LIBRARY

Kirkpatrick, Col. Elmer E., Jr., 526–27, 534, 536, 540, 542, 595
Kirtland Field, N.Mex., 408, 581
Kistiakowsky, George B., 350, 506, 511
Klein, August C., 53, 127, 136
Knolls Atomic Power Laboratory, 592
Knoxville Airport, Tenn., 408
Kobe, Japan, 528
Kokura Arsenal, Japan, 529, 536, 538
Kolm, 305
Kowarski, Lew, 8*n*, 66, 249
Krug, J. A., 385, 387
Kruger, Willard C., and Associates, 466–68
Kyle, Col. William H., 274, 560
Kyoto, Japan, 529–30
Kyoto Imperial University, Japan, 586

Lancaster (British aircraft), 510*n*, 520
Land acquisition
  Clinton Engineer Works, 319–22
    Congressional investigation of, 325–27
    cost of, 327–28
    local opposition to, 322–24
  Hanford Engineer Works, 331–33
    condemnation trials for, 336–42
    cost of, 342
    local opposition to, 334–36
  Los Alamos, 328–31
  other sites, 342–43
Landrum, C. U., 339
Lansdale, Col. John, Jr., 298, 306
  counterintelligence system, 255, 257, 263
  Operation HARBORAGE, 289, 341
Lanthanum fluoride, 193–94
L'Arcouest, France, 286
Latimer, W. M., 121*n*
Lattice pile, 28, 30
Laurence, William L., 514, 554–55
Lavender, Capt., Robert A., 248
Lawrence, Ernest O., 28, 30, 38, 44, 66, 514, 531, 583, 589
  electromagnetic process, 34–35, 47, 52–53, 70, 118–21, 123, 125, 128–29, 138
  Los Alamos site selection, 84–85, 87
  pile process, 99–101
Leahy, Admiral William D., 561, 564, 565*n*, 566
Lee, Frank G., 299
Lee, Rear Adm. Willis A., Jr., 44, 77
Leith, Charles K., 299
LeMay, Maj. Gen. Curtis, 526, 534, 536
Lewis, Warren K., 563, 589
  liquid thermal diffusion process, 174–77
  plutonium project, 101, 197, 490
Lewis reviewing committee, 101–02, 104–05, 117, 149, 174
Lilienthal, David E., 381, 386, 574, 597–99
Lincoln, Brig. Gen. George A., 519*n*
Lindau, Germany, 289
Linde Air Products Company, 151, 160, 310, 314–16. *See also* Union Carbide and Carbon Corporation.
Liquid thermal diffusion (S–50) process, 31*n*, 36
  full-scale development of, 174–78
  Navy R & D on, 149*n*, 172–75, 177–78
  plant construction, 179–80
  plant design, 178–79
  plant operation, 180–83, 580
Littell, Norman M., 336–41
"Little Boy," 522, 535–38. *See also* "Thin Man."
Llewellin, Col. John J., 241–43, 305
Lockhart, Jack, 554
Los Alamos Laboratory
  accidents at, 420*n*
  administrative organization, 491–93
  atomic communities, 465–81
  censorship at, 278–79
  communications and transportation at, 395–98, 400–401, 404, 408
  electrical power for, 385, 388
  espionage at, 265–66
  Groves's efforts at, 485–86, 500–501
  health and safety programs at, 416–17, 419–20, 424–26, 428–29
  interchange with British scientists, 231, 245
  land acquisition for, 328–31
  manpower recruitment for, 347–48, 353, 358, 487, 501–02
  post administration, 496–502
  postwar operations, 580–82, 585, 593–94
  site selection for, 82–88, 478
  special reviewing committee, 490–91
  technical organization, 493–96
  weapon construction at, 507–10
  weapon design at, 503–07
  weapon planning at, 488–91
  weapon testing at, 511–18
Los Alamos Ranch School for Boys, 84, 329, 465–66, 472
Lotz, John R., 55–56, 69
Louisville and Nashville Railroad, 397, 404–05, 433
Ludwigshafen, Germany, 288

MacArthur, General Douglas, 530, 534, 543–44, 587–88
Mackenzie, C. J., 232, 235, 243, 246–47
Maddy, James R., 426–27, 429
Mahon, George H., 274
Maizuru, Japan, 528
Makins, Roger, 560–61, 571–72
Mallinckrodt, Edward, 62
Mallinckrodt Chemical Works, 62, 64, 310, 315–17
Manhattan (code name for American atomic project), 43–44
Manhattan District, 40–41, 80, 595
  administrative organization, 88–91, 256–59, 308, 346–47, 412–13, 420, 437–38

NEWARK PUBLIC LIBRARY

Manhattan District—Continued
  and the AEC, 596–97, 600*n*
  area offices. *See* Engineers offices.
  deferment policies, 367–69
  establishment of, 41–46
  labor relations activities, 363–66, 370–75
  and plant operations, 142–43, 150–51, 160, 166
  Oak Ridge community development, 434–40, 443, 445–46
  Production Control Committee, 169
  relations with Los Alamos, 468–69, 477
  report on bombing effects, 545–46
  security systems, 254–59, 274–77, 279
Manhattan Project
  and atomic energy legislation, 574–78
  and the bombing of Japan, 521–23, 543–47, 550
  end of, 599–600
  funding for, 115–16, 272–74, 590
  major installations. *See* Clinton Engineer Works; Hanford Engineer Works; Los Alamos Laboratory.
  organization of, 88–92, 588–90
  origins of, 19–39
  policymaking bodies. *See* Interim Committee; Military Policy Committee; Top Policy Group.
  postwar operations, 580–85, 588–96
  priority ratings for, 80–82
  public relations program, 553–62
  Soviet interest in, 265–66, 564
Manley, John H., 527, 594
Manpower conservation, 375–76
  labor turnover, 363–66
  procedures for grievance hearings, 374–75
  security, 366–67, 369, 371–72
  Selective Service System, 366–69
  union activities and work stoppages, 369–76
Manpower procurement, 344–45, 361–62
  of civilian employees, 355–57
  of industrial labor, 350–55
  of military personnel, 357–61
  organization for, 345–48
  of scientific and technical personnel, 348–50
Marbury, William L., 568
Mariana Islands, 521, 523
Marks, Herbert S., 380–81, 597–98
Marsden, Lt. Col. E. H., 112, 308*n*
Marshall, General George C., 42, 98, 273, 580
  ALSOS mission, 280–81, 289
  Anglo-American collaboration, 234, 239–41
  atomic energy program, 26, 31, 34, 37, 39, 73–74, 76
  bombing of Japan, 524, 528, 534, 541, 543
Marshall, Col. James C., 19, 31*n*, 39, 55–56, 88*n*, 115, 255, 307, 356, 426
  electromagnetic program, 118, 128, 133
  establishment of Manhattan District, 40–42, 45–46
  financing of atomic project, 49–50, 56–57
  Oak Ridge community development, 434–35
  plutonium program, 96, 113, 185, 194, 205
  priority ratings, 57, 59, 61
  research and development, 50, 52–53
Marshall, Col. James C.—Continued
  site selection, 47, 68–70, 78, 434
Martin, Joseph W., Jr., 273
Martyn, John W., 587
Massachusetts Institute of Technology, 64, 308, 314, 317–18, 487, 590
Materiel Squadron, 1027th, 521
Matthias, Lt. Col. Franklin T., 276, 375
  Hanford Engineer Works
    community development, 452–55, 457–60
    electrical distribution system, 391–93
    land acquisition, 110, 333–34, 336–38, 342
    transportation, 405–06, 409
  plutonium project, 201–02, 210–21
May, Andrew J., 325, 575
May-Johnson bill, 575–77
McCloy, John J., 378, 567, 573
McCormack, John W., 273
McGrady, Edward, 374
McKee, Robert E., 371, 469, 471, 498
McKellar, Kenneth D., 595
McLeod, Capt. Robert J., 256, 258
McMahon, Brien, 576–77
McMahon bill (Atomic Energy Act of 1946), 577–78
McManama and Company, 455
McMillan, Edwin M., 8*n*, 84, 100
McNarney, Lt. Gen. Joseph T., 285
McNeil Island Penitentiary, Wash., 334
Mead, James M., 335*n*
Mead Committee. *See* U.S. Congress, Senate.
Medical Corps, 413, 416, 422, 425, 544
Meitner, Lise, 7, 290
Menke, Capt. Bernard W., 258
Merritt, Capt. Phillip L., 80, 307
Metal Hydrides, Inc., 62, 64, 310, 316–17
Metallurgical Laboratory, 47, 342, 347, 350, 385, 487, 576
  chain reaction, 102–03
  Du Pont collaboration, 194–97, 452, 454
  espionage at, 265
  feed materials processing, 313, 317–18
  health programs, 410*n*, 415, 419*n*
  pile design and engineering, 185–93
  plutonium program, 35–36, 52, 65–66, 72, 86, 95–101, 113, 510, 583, 590, 592
  See also Metallurgical Project; University of Chicago.
Metallurgical Project, 371, 563, 590
  Council, 204
  Du Pont collaboration, 203–04
  plutonium program, 199–200
  transfer of physicists, 501
  See also Argonne Laboratory; Clinton Laboratories; Metallurgical Laboratory.
Metals Reserve Corporation, 311
Middlesex, N.J., 80
Miles, J. B., 204
Military Advisory Board, 589
Military Appropriations Act of 1944, 116
Military Intelligence Service, WD, 255

Military Liaison Committee, AEC, 578, 597–98
Military Police Company (Aviation), 1395th, 521
Military Policy Committee, 77, 80, 266, 293, 557, 580
  administration of Manhattan Project, 89, 115, 589
  Anglo-American collaboration, 227, 231–32, 234–35, 242–43, 245
  bombing mission, 524–526
  Hanford land acquisition, 335–37
  implosion program, 507–08, 510*n*
  Los Alamos, 87, 494
  plutonium project, 99, 105–07, 109, 184–85, 191, 194, 198, 203
  postwar policy on atomic energy, 563
  production methods, 117, 139
  raw materials, 293, 295–96
Millikin, Eugene D., 577
Mills, Rear Adm. Earle W., 563
Mitchell, Dana P., 492
Mohler, Fred L., 21
Monsanto Chemical Company, 210, 508, 544, 591
Moore, Lacey, 406
Moore, Thomas V., 185
Moran, Maj. John J., 166
Morgan, J. E., and Sons, 469, 471
Morgantown Ordnance Works, W.Va., 107–08, 191, 343
Morgenthau, Henry, 67, 302
Morrison-Knudsen Company, 371
Moses, Brig. Gen. Raymond G., 44
Mountain States Telephone and Telegraph Company, 395–96
Munnecke, Wilbur C., 200
Muroc Army Air Field, Calif., 508, 520
Murphree, Eger V., 34, 36, 38, 44, 51, 101
  heavy water program, 197
  liquid thermal diffusion process, 174–77
Murray, Philip, 373

Nagaoka, Japan, 528
Nagasaki, Japan, 530, 536
  bombing of, 538, 540–41
  survey teams at, 544–46, 548
Nash Building, 150–51, 155
National Academy of Sciences, 30, 32–33
National Bureau of Standards, 21, 23–24, 27, 62, 64–65, 173, 308, 316–18, 419*n*, 487
National Carbon Company, 65–66, 313
National Defense Research Committee, 26–31, 33–34, 254, 490, 505
National Electrical Contractors Association, 354
National Homes, 437
National Labor Relations Board, 345, 372–73
National laboratories, 590–91
National Research Council, 253, 345
National Roster of Scientific and Specialized Personnel, 358, 492
National Safety Council, 428–30
National War Labor Board, 355, 364, 372
Naval Construction Brigade, 6th, 524
Naval Depot, Yorktown, Va., 508
Naval Gun Factory, Wash., D.C., 505–08
Naval Ordnance Plant, Centerline, Mich., 508
Naval Proving Ground, Dahlgren, Va., 508
Naval Research Laboratory, 12–13, 22, 24, 31*n*, 173–74
Naval Technical Mission to Japan, 545
Neddermeyer, Seth H., 506
Nelson, Lt. Col. Curtis A., 501
Nelson, Donald, 59, 81, 381
Neptunium, 28
Netherlands East Indies, 306
Newman, Brig. Gen. James B., Jr., 544
Newman, James R., 577
New Mexico Power Company, 331*n*, 388
Newton, Isaac, 3
New War Department Building, 42, 89, 597
Nichols, Col. Kenneth D., 42, 46–47, 53, 55, 88, 380, 509, 543
  Anglo-American collaboration, 233, 241
  electromagnetic construction, 133–36, 139, 146
  feed materials program, 307–08
  gaseous diffusion plant, 160, 169
  Hanford production plant, 109, 218, 220, 592
  liquid thermal diffusion process, 174, 177–78, 182
  manpower conservation, 369, 374
  Oak Ridge community development, 437, 443–44
  plutonium project, 98, 112–14, 185, 194, 202, 209
  postwar commitments, 588–89
  priority ratings, 57–60
  reorganization of atomic project, 75–76
  security system, 258
  silver procurement, 66–67
  site selection, 68, 71
  Smyth *Report*, 559–60
  transfer of Manhattan Project to AEC, 598–600
  uranium procurement, 62, 65, 79, 292, 295
  weapon stockpiling, postwar, 593–94
Nickel barrier, 154–57
Nickel chromium, 312
Nier, Afred O., 10
Niigata, Japan, 529, 540
Niihama, Japan, 528
Nimitz, Admiral Chester W., 524, 526, 535
Nitrogen, 4, 133
Nolan, Capt. James F., 420, 425–26, 536
Norris, Edward, 154–57
Norris Dam, Tenn., 390–91
Norsk Hydro plant, Rjukan, Norway, 23, 66, 280
Norstad, Brig. Gen. Lauris, 524, 528
Northern Pacific Railroad, 405, 407, 460
Norton, William J., 126

Oak Ridge, Tenn., 79, 88, 201, 361, 382, 389–91, 421–23, 427–30, 435–40, 443–44, 448
Oak Ridge Institute of Nuclear Studies, 591
O'Brien, Col. John J., 78, 110, 324

- OCTAGON Conference, 564
- O'Driscoll and Grove, 437
- Office of Censorship, 278–79, 514, 554
- Office of Defense Transportation, 404–05, 407–08, 459
- Office of Naval Intelligence, 255, 280
- Office of Scientific Research and Development, 28, 36–37, 39, 254
  - Army collaboration, 46–50, 66–67, 69, 71–72
  - Committee on Scientific Personnel, 345, 349
  - electromagnetic program, 118, 119*n*, 120–21
  - health and safety measures, 410–11
  - and the Manhattan District, 40, 44–47, 49
  - materials procurement, 292, 307, 315–16
  - S-1 Executive Committee, 77–81
    - Anglo-American relations, 228–30
    - electromagnetic process, 117, 126
    - gaseous diffusion process, 51
    - liquid thermal diffusion process, 174–75
    - Manhattan Project administration, 71–72, 89–90
    - organization of, 44–46
    - plutonium project, 52–53, 96–97, 101, 107
    - procurement, 58–59, 65–66
  - S-1 Section, 33–35, 44, 62, 292
- Office of Strategic Services, 280
- Office of the Surgeon General, 412, 422
- Office of War Utilities. *See* Power Division, WPB.
- Ohio State University, 151
- Ohly, John H., 373
- Okinawa, 541
- O'Leary, Jean, 89
- Oliphant, Marcus L. E., 124, 147, 242*n*, 243, 245
- Olympic Commissary Company, 461
- O'Meara, Capt. Paul E., 435, 437
- Omura Naval Hospital, Japan, 544
- Oolen, Belgium, 25
- Operation CROSSROADS, 594
- Operation HARBORAGE, 289–90
- Operation PEPPERMINT, 284–85
- Oppenheimer, J. Robert, 52, 71, 271, 574
  - decision to use the bomb, 531–32
  - electromagnetic process, 128
  - implosion bomb design, 503, 506–07, 509–15
  - liquid thermal diffusion process, 175–76
  - Los Alamos Laboratory
    - establishment of, 82–84, 86–88
    - organization of, 491–96, 499–500
    - postwar personnel attrition, 581–82
    - recruiting of scientists, 347, 350
    - weapon planning, 488–91
  - Los Alamos operating community, 466–67, 475, 481
  - Radiation Laboratory espionage reports, 264
  - security clearance for, 261–62
- Orange oxide, processing of, 315
- Oranienburg, Germany, 287–88
- Ordnance Department, 23–24, 108, 495
- Osaka Imperial University, Japan, 586
- Pacific and National Hut, 470
- Pacific Power and Light Company, 381–82, 391–93, 451
- Pacific Telephone and Telegraph Company, 394, 396
- Page, Arthur, 554–55
- Pajarito Plateau, N.Mex., 465, 478
- Parsons, Lt. Col. William B., 258
- Parsons, Rear Adm. William S., 499, 501, 598
  - bomb development, 504, 506, 508
  - liquid thermal diffusion process, 175
  - preparations for atomic bombing, 521, 527, 535–38
- Pasco, Wash., 110, 405–06, 456, 460
- Pash, Lt. Col. Boris T., 261–62, 281–82, 286, 288–90
- Patent rights, 247–48
- Patterson, Robert P., 74, 78, 111, 302, 354–55, 374, 584, 597, 600
  - electric power requirements, 381, 386–87
  - land acquisition, 319, 325, 331, 338, 340
  - Manhattan Project appropriations, 273–74
  - postwar atomic policy, 570–71, 575, 577
- Patterson-Brown Plan, 354
- Peabody, A. O., 398
- Pearson, Lester B., 571
- Pegram, George B., 8*n*, 12, 24–25, 34–35, 44
- Pehrson, G. A., 457–58
- Peierls, Sir Rudolph E., 8*n*, 242*n*, 243, 245
- Penn Salt, 314
- Penney, William G., 528
- Personnel
  - for ALSOS mission, 281, 285–86
  - attrition, postwar, 581–85
  - for Clinton Laboratories, 208
  - for electromagnetic plant, 141–42
  - for gaseous diffusion plant, 151, 166–67
  - for Hanford production plant, 214, 218–19
  - for Los Alamos, 487, 492–93, 497–98, 501–02
  - for Manhattan District security force, 258
  - medical, 412–14, 422, 425
  - *See also* Manpower conservation; Manpower procurement.
- Persons, Brig. Gen. William B., 337
- Peterson, Maj. Arthur V., 114, 188, 194, 196–97, 201–02, 208–09, 283–84
- Philadelphia Navy Yard, 175–76, 594
- *Physical Review*, 14
- Pierce Foundation, John B., 435
- Pike, Sumner T., 597–98
- Pile (X-10) process, 184–85, 419
  - Army-Du Pont administration, 202–04
  - chemical separation process design, 193–94
  - Clinton Laboratories
    - plant construction, 205–08
    - plant operation, 208–10, 583, 591, 594
  - design and engineering for, 184, 187–94
  - Du Pont-Metallurgical Laboratory collaboration, 194–98

NEWARK PUBLIC LIBRARY

Pile (X-10) process—Continued
  Hanford Engineer Works
    plant construction, 212–18
    plant operation, 219–23, 581, 585, 592–93
  research and development, 51–52, 99, 102–05, 184–85
Plutonium (Pu-238, -240), 28–30, 32–34, 36, 38, 99, 283, 488–90, 504–05, 508–09, 514
Pond, Ashley, 465
Port Hope, Ontario, 62, 64, 79–80, 313–14
Port Richmond, N.Y., 65
Postwar Policy Committee, 563–64
Potsdam Conference, 555
Potsdam Declaration, 541
Power Division, WPB, 380, 382, 384, 387–88, 597
Prefabricated Engineering Company, 458–59
Press releases. *See* Manhattan Project, public relations program.
Price, Byron, 278
Priest Rapids Branch. *See* Chicago, Milwaukee, St. Paul and Pacific Railroad.
Priestly, Kenneth, 123
Princeton University, 8, 27–28, 47, 52, 590
  barrier corrosion research, 151, 154
  feed materials research, 308, 317–18
Priority ratings
  for labor, 352–53
  for tools and materials, 80–82
  for weapon development, 50, 57–61
Prisoner-of-war camps, 537, 547
Procurement, 130–33, 206, 217, 455, 486, 491, 499–500
  of copper, 61, 66
  of electric power and equipment, 377–80, 393
  of feed materials, 310–14
  of graphite, 22–23, 61, 65–66, 312–13
  of heavy water, 61, 66
  of raw materials. *See* Raw materials program.
  of silver, 66–67, 133
  of thorium ore, 292–95, 300, 303, 305–07
  of uranium ore, 62, 64–65, 79–80, 286–87, 292–95, 300, 303, 310–11
Procurement and Assignment Service, 413
Project Alberta, 496, 542
Project Camel, 499, 501, 510
Project Trinity, 496, 503, 581*n*
  bomb test, 514–19
  establishment of base camp, 478–81
  origin of code name, 465*n*
  preparations for, 511–14
"Prospectus on Nucleonics," 563
Provisional Engineer Detachment, 469, 473–74, 497–98, 502, 507
Public Roads Administration, 403–04
Pumps, design of, 157–58
"Pumpkins," 511
Purdue University, 86, 119*n*, 126, 145, 314, 487
Purnell, Rear Adm. William R., 77, 174, 350, 524, 526, 534

QUADRANT Conference, 240–41
Quebec Agreement, 241–42, 245, 247, 249
  British proposed revision of, 570–72
  uranium resources, 296*n*, 299*n*

Rabi, Isidor I., 488
Racetracks. *See* Alpha racetracks; Beta racetracks.
Radiation, 3–4, 415–16
Radiation Laboratory, 35, 125, 343, 411*n*
  espionage at, 261, 263–65
  research and development, 120–26, 128–29, 138, 141–42, 583
  See also University of California (Berkeley).
Radioactive lead, 312–13
Radioactive warfare, 283–84
Radioactivity, 543–44, 547, 562*n*
Radium, 8, 25, 312–13
Radium Chemical Company, 312
Railroads, 404–08
Ramsey, Norman F., 349
Raw materials program
  acquisition in foreign areas, 299–306
  international ore exploration, 292–95
  joint control of Congo ore, 295–97
Rayburn, Sam, 273–74
Rea, Lt. Col. Charles E., 420
Read, Granville M., 199, 203
Reader's Digest, 548
Real estate branches
  Corps of Engineers, 70, 78, 324, 331, 340, 342
  Ohio River Division, 70, 320–21, 404
  Pacific Division, 331–34
  Southwestern Division, 328, 331
Reconstruction Finance Corporation, 311*n*
Redox solvent extraction process, 593*n*
Reybold, Maj. Gen. Eugene, 19, 40, 42–43, 55, 75, 115, 319, 326
Rice, Calif., 478*n*
Richards, Maj. Gen. George J., 273
Richland, Wash., 110, 212, 332–33, 392, 401, 406, 428, 430, 450–51, 456–60, 462–64
Rickover, Capt. (USN) Hyman G., 596*n*
Rjukan (Norway) plant, 280. *See also* Norsk Hydro plant.
Road systems, 400–404
Roane-Anderson Company, 371, 427
  Oak Ridge community administration, 444–47
  operation of CEW communications and transportation, 397–98, 401, 404
Roane County, Tenn., 70, 78, 320, 326, 403
Roberts, Richard B., 21
Robins, Brig. Gen. Thomas M., 41–42, 55, 70, 77, 110
Roentgen, Wilhelm, 4
Roosevelt, Franklin D., 73, 80, 98, 115, 197
  Anglo-American collaboration, 31–32, 46, 228–29, 232–33, 236–38, 240, 251
  approved briefing congressional leaders, 272–73

- Roosevelt, Franklin D.—Continued
  - control of Congo ore deposits, 297–300
  - government support of atomic energy program, 13–15, 19, 26, 28, 31–32, 39
  - Hanford land acquisition, 335–36
  - Los Alamos security, 494
  - Navy exclusion from atomic program, 31, 174
  - postwar planning, 564–66
  - Quebec Agreement, 241–42
- Rose, Edwin L., 490
- Rosenberg, Ethel and Julius, 265
- Rossell, Maj. Paul F. 438
- Rowe, Hartley, 496
- Royall, Brig. Gen. Kenneth C., 568–69
- Royall-Marbury draft bill, 568–69, 574–75
- Ruhoff, Lt. Col. John R., 146, 589
  - feed materials program, 307–08, 311
  - uranium procurement, 64–65, 79
- Russell, Richard B., 577
- Rutherford, Ernest, 4–6

- S (Sawmill) site, 507
- S-1 Executive Committee. *See* Office of Scientific Research and Development.
- S-1 Section. *See* Office of Scientific Research and Development.
- Sabotage, measures against, 266–67
- Sachs, Alexander
  - Congo ore acquisition, 24–25
  - government support of atomic program, 13–15, 19–24, 26, 28
- Safety program
  - insurance plans, 430–31
  - occupational and community aspects, 428–30
  - organization of, 426–28
- Salton Sea Naval Air Station, Calif., 521
- SAM (Special Alloyed Materials) Laboratories, 150, 153–54, 156, 167, 343
- Sandia Base, N.Mex., 581, 585, 594, 599
- San Luis Valley, Colo., 478*n*
- San Nicolas Island, Calif., 478*n*
- Sapper, Maj. William L., 112, 201–03
- Schulman Electrical Company, A. S., 389
- Schult Trailers, 437
- Schwellenbach, Judge Lewis B., 331, 337, 339–40, 342
- Seaborg, Glenn, 99, 173, 185
- Secrecy, 26, 44–45, 56
- Security
  - bodyguards, 267–68
  - censorship, 277–79
  - Clinton Engineer Works, 447
  - communications, 395–97
  - compartmentalization policy, 268–72
  - counterintelligence program, 255–57, 259–63
  - espionage activities, 263–66
  - French repatriated scientists, 249, 252
  - Hanford Engineer Works, 461, 463
  - informing Congress, 272–74
- Security—Continued
  - Los Alamos, 474, 480, 491–92, 494–95, 513–14, 517
  - measures against sabotage, 266–67
  - organization and administration of, 254–59, 274–76
- Selective Service System, 344, 346, 366–69, 376
- Senate committees. *See* U.S. Congress, Senate.
- Seneca Ordnance Depot, N.Y., 80
- Sengier, Edgar, 25, 64–65, 79–80, 292, 295, 300
- Separation methods, 9–11, 21, 23, 28–30, 34–37, 193–94. *See also by process names.*
- Service Commands
  - 4th, 395–96
  - 6th, 358
  - 8th, 358, 361, 474, 497, 502
  - 9th, 396, 408
- Service Command Unit, 4817th, 361, 474
- Services of Supply, 19, 40, 57, 116*n*, 358, 486. *See also* Army Service Forces.
- Shane, Charles D., 492–93
- Shasta Dam, Calif., 70, 110
- Shekerjian, Lt. Col. Haig, 20
- Shinkolobwe mine, Belgian Congo, 8, 25, 64, 295–96, 300
- Short, Dewey, 325
- Shurcliff, William S., 558
- Signal Corps, 377, 395–96, 544
- Silver Spring, Md., 508
- Simon, Sir Francis E., 242*n*, 243
- Site selection
  - Chalk River pilot plant, 246–47
  - Clinton Engineer Works, 78–79, 435–40, 450–51
  - Hanford Engineer Works, 108–11
  - Los Alamos Laboratory, 82–88, 478
  - other installations, 46–49, 65–71
- Skidmore, Owings and Merrill, 435–36, 438–39, 441
- Slotin, Louis, 420*n*
- Smith, Harold D., 34
- Smith, Hoffman, and Wright, 458
- Smith, Lincoln G., 558
- Smith, Capt. Ralph C., 500
- Smith, Lt. Gen. Walter Bedell, 284
- Smyth, Henry D., 196, 556–63
- Smyth *Report*, 556–61
- Snyder, J. Buell, 274
- Sobell, Morton, 265
- Soda salt, processing of, 314–15
- Solberg, Rear Adm. Thorvald A., 563, 598
- Somervell, Lt. Gen. Brehon B., 116, 338, 348
  - establishment of Manhattan District, 42–43
  - organization of atomic energy program, 74–75, 77
- Southern Bell Telephone and Telegraph Company, 396–97
- Southern Railway, 320*n*, 397, 404, 433
- Soviet Union
  - espionage activities, 265–66
  - postwar atomic explosion, 566*n*
  - proposed atomic relations with, 564, 570
- Spaak, Paul H., 300

NEWARK PUBLIC LIBRARY

Spaatz, General Carl A., 288, 537*n*
Sparkman, John, 325
Special Engineer Detachment, 141, 151, 166, 180–81, 208, 349, 358–59, 367, 469, 497–98, 502, 507
Special Engineer Detachment (Provisional), 13th, 258
Spedding, Frank H., 145, 185
Speer, Albert, 291
Speer Carbon Company, 65–66, 313
Spokane Army Air Field, Wash., 409
Spokane, Portland, and Seattle Railroad, 405, 407
Spokesman-Review (Spokane, Wash.), 279
Sproul, Robert G., 126
Stadtilm, Germany, 288–89
Standard Oil Development Company, 27, 36, 51, 65, 79, 96
Stanford University, 487
Stark, Admiral Harold R., 26
Staten Island cache, 64–65, 79–80, 292
Stearns, Joyce C., 528
Steel, procurement of, 61, 218
Steel-bomb process, 64
Stettinius, Edward R., Jr., 306
Stevens, Maj. Wilber A., 500, 507
Stewart, Irvin, 44
Stewart, Lt. Col. Stanley L., 499, 501
Stewart, Tom, 595
Stagg Field, University of Chicago, 103, 194
Stassfurt, Germany, 287
State, County, and Municipal Workers of America, 371
Stimson, Henry L., 67, 98, 126, 580
  ALSOS mission, 280, 289
  Anglo-American collaboration, 229, 232, 234, 237–40, 251
  atomic energy program, 39, 73, 77
  bombing of Japan, 529–30, 532, 537*n*, 541, 545
  briefing congressional leaders, 573–74
  Combined Policy Committee, 241–42
  deferments, 367–68
  establishment of Manhattan District, 45–46
  Hanford land acquisition, 335–37
  joint control of Congo uranium, 296–98, 300, 302
  manpower recruitment, 349, 353–54, 357
  postwar planning, 565–68, 570
  press release on bombing, 553, 556
  priority ratings, 61
  Project Trinity, 517–18
  Smyth *Report*, 560–61
  Top Policy Group, 31, 33–34
Stine, Charles, 98, 100
Stone, Robert S., 200, 410*n*, 411, 415
Stone and Webster Engineering Corporation, 42, 49, 52, 68–71, 79, 185, 428*n*
  acquisition of feed materials, 307, 311
  as an AEM, 55–56, 59, 61, 95–97, 99, 106–07
  CEW communications and transportation, 396, 398, 404
  CEW housing construction, 433–37, 439, 441, 443
Stone and Webster Engineering Corporation—Continued
  electromagnetic plant
    construction of, 130, 132–37, 139, 389–90
    design and engineering of, 124, 126–29
Stowers, Lt. Col. James C., 151, 156, 160, 166
Strasbourg, France, 287, 290
Strassmann, Fritz, 7, 8*n*, 290
Strauss, Lewis L., 597
Strong, Maj. Gen. George V., 26, 255–56, 277, 280–81
Styer, Maj. Gen. Wilhelm D., 19, 37–38, 46, 59, 206, 381
  Combined Policy Committee, 242–43
  establishment of Manhattan District, 40, 42–43, 45
  foreign ore acquisition, 300
  manpower procurement, 350, 354, 356
  reorganization of atomic energy program, 74–77, 81–82
Sundt Company, M. M., 398, 466, 468–69, 474
Supreme Headquarters, Allied Expeditionary Force, 289–90
Surplus property, 595
Suzuki, Kantaro, 542
Swanson, Maj. Melvin O., 438
Sweeney, Maj. Charles W., 540
Syracuse District, 19, 42, 356
Szilard, Leo, 8*n*, 10–11, 190
  compartmentalization policy, 270–71
  development of atomic energy program, 24, 26
  efforts to secure U.S. government support, 12–14
  uranium-graphite system, 11, 21–22

Taber, Rep. John, 274
Tailfingen, Germany, 290
Taranto, Italy, 281
Taylor, Hugh S., 47, 49
Taylor, Capt. Thomas W., 438
Technical Detachment, 1st, 521, 527, 535, 542
Technical Service Unit, 9812th, 361, 497–98
Teller, Edward, 8*n*, 11, 13, 271, 503*n*
  development of atomic energy program, 21–22
  Los Alamos weapon program, 487
Tennessee Eastman Corporation, 119*n*, 126
  hazards control program, 418–19
  labor relations, 371, 374
  operation of electromagnetic plant, 107, 124, 134, 140–48, 398
Tennessee Valley, 55, 71, 78–79
Tennessee Valley Authority, 108
  electrical power from, 378–83, 386, 389–91
  site selection, 46–47, 68–69, 432
"Thin Man," 508. *See also* "Little Boy."
Thomas, Charles A., 210, 509, 514, 574, 589
Thomas, Elmer, 273
Thomas, W. I., 177
Thomson, George P., 8*n*
Thomson, J. J., 4

NEWARK PUBLIC LIBRARY

Thorium ore. *See* Procurement, of thorium ore.
Tibbets, Col. Paul W., Jr., 521, 529, 537–38
Tilley, John N., 199
Tinian, 524, 526–27, 536, 538, 540–44
TNX Division. *See* Du Pont, E. I., de Nemours and Company.
Tojo, General Hideki, 542
Tolman, Richard C., 197, 271, 350, 529, 589
  Combined Policy Committee, 242–44
  liquid thermal diffusion process, 176–77
  Los Alamos weapon program, 490, 503*n*, 507, 510, 512–14
  postwar planning, 558–60, 563, 574
Top Policy Group, 31, 34–35, 45–46, 80, 89, 232, 267, 296
Toyama, Japan, 528
Trail plant, British Columbia, 47, 53, 58–59, 61, 66–67, 72, 107, 343, 388, 581
Transportation
  air, 408–09
  Corps, 377, 398–401, 405
  motor vehicles, 400–402
  organization for, 399–400
  problems of, 397–98
  railroads, 404–08
  road networks, 402–04
Travancore, India, 305–06
Travis, Maj. James E., 203
Traynor, Maj. Harry S., 45*n*, 297–98
TRIDENT Conference, 235
Trinity. *See* Project Trinity.
Tripartite Agreement, 300–301
Troop Carrier Squadron, 320th, 521
Truman, Harry S., 337, 518
  appointments to AEC, 596–97
  bombing of Japan, 533, 541, 556
  domestic control of atomic energy, 575–76, 578
  future control of the bomb, 569–74
  postwar planning, 561–62
Truman-Attlee-King Declaration, 571, 573
Truman Committee. *See* U.S. Congress, Senate.
Trytten, M. H., 492
Tube Alloys (code name for British atomic project), 99, 228–29, 223, 236, 304, 565, 570
Tularosa valley, N.Mex., 478*n*
Turner Construction Company, 444
Twaits, Morrison, and Knudsen, 458
Tydings, Millard E., 577
Tyler, Col. Gerald R., 498, 501

Ube, Japan, 528
Underhill, Robert M., 121–23
Uniform Vehicle Code, 429
Union activities, 369–75
Union Carbide and Carbon Corporation, 96, 106, 165, 293. *See also* Bakelite Corporation; Linde Air Products Company; Union Mines
Union Carbide and Carbon Corporation—Continued
    Development Corporation; United States Vanadium Corporation.
Union Mines Development Corporation, 293–95, 299*n*, 303. *See also* Union Carbide and Carbon Corporation.
Union Miniere du Haut Katanga, 8, 25, 286, 300–301, 310. *See also* African Metals Corporation.
Union Pacific Railroad, 405, 407, 460
United Nations
  Article 102 of charter, 571–72
  Commission on Atomic Energy, 573–74
United States Army Strategic Air Forces, 288, 530
United States Atomic Energy Commission, 67*n*, 342, 376, 578, 591, 596–600
United States Bullion Depository, West Point, N.Y., 133
United States Employment Service, 141, 351–53, 366
United States Strategic Bombing Survey, 545, 547–48, 550
United States Vanadium Corporation, 311. *See also* Union Carbide and Carbon Corporation.
University of California (Berkeley), 348, 371, 428*n*, 487, 589
  Board of Regents, 120
  electromagnetic program, 119–23
  Los Alamos prime contractor, 86–87, 467–68, 475, 486–87, 491, 499, 512
  nuclear research, 8, 27–28, 52, 83, 185, 193
  See also Donner Laboratory; Radiation Laboratory.
University of California (Davis), 119, 123
University of Chicago, 68, 86, 121, 590, 594
  nuclear research, 27–28, 52, 83
  plutonium program, 185–87, 193–94, 210
  plutonium semiworks, 114–15, 398
  See also Metallurgical Laboratory.
University of Illinois, 86, 487
University of Minnesota, 27, 86, 487
University of Pennsylvania, 590
University of Rennes, France, 286
University of Rochester, 411–12, 415–16, 421, 487, 544, 590, 594
University of Rome, 282
University of Strasbourg, 287
University of Tennessee, 142, 591
University of Virginia, 23–24, 27, 51
University of Washington, 415
University of Wisconsin, 86, 487
Uranium (U–233, –234, –235, –238), 8–11, 23–25, 28–29, 32–33
  and bomb development, 504–06, 508, 510
  British research on, 231, 235
  electromagnetic process, 128, 142–44
  explosive potential of, 488–89
  gaseous diffusion process, 149, 152, 169, 171
  Lewis reviewing committee report on, 104–05
  liquid thermal diffusion process, 173, 175–77, 182
Uranium, Committee on, 26–28, 253. *See also* Uranium, Section on.

- Uranium, Section on, 28, 556. *See also* Office of Scientific Research and Development, S-1 Section.
- Uranium Committee. *See* Advisory Committee on Uranium.
- Uranium-graphite system, 11, 21, 23, 28
- Uraniam hexafluoride, 152, 154, 173, 175
- Uranium ore. *See* Procurement, of uranium ore.
- Uranium tetrachloride, 143
- Uravan, Colo., 376
- Urey, Harold C., 24, 26, 30, 34–35, 44, 87, 243, 574
  - gaseous diffusion process, 34, 36, 38, 51, 101, 150, 155
  - liquid thermal diffusion process, 174–75
- U.S. Congress, 327, 576, 579–80, 590, 595
  - atomic project briefings, 272–74
  - hearings on atomic bombings, 548–50
  - House of Representatives, 273–74, 324, 576, 578
    - Appropriations Committee, 273–74
    - Military Affairs Committee, 75, 325, 575, 578–79
  - postwar atomic legislation, 572, 574–78
  - Senate, 273, 336, 578
    - Appropriations Committee, 273
    - Mead Committee, 341
    - Military Affairs Committee, 575–76
    - Special Committee on Atomic Energy, 548, 577–80
    - Truman Committee, 279, 335, 337
- U.S. Navy, 12–13, 22, 24, 31*n*, 172–75, 177–78, 255, 524, 535, 545, 576, 594*n*

- Vanadium, 311
- Vanadium Corporation of America, 311
- Vance, Maj. John E., 306
- Vanden Bulck, Lt. Col. Charles, 43*n*, 357, 597–98
- Vandenberg, Arthur H., 576–77
- Van Fleet, J. R., 293
- Van Vleck, John H., 490
- Vargas, Getulio, 306
- Ventures, Ltd., 299*n*
- Vitro Manufacturing Company, 308, 314
- Volcano Islands, 540
- Volpe, 1st Lt., Joseph, Jr., 278, 306, 597–98
- von Halban, Hans, 8*n*, 66, 235, 243, 246–47, 249–50
- von Neumann, John, 506, 528

- Wabash River Ordnance Works, Ind., 108, 191, 343
- Wakayama, Japan, 528
- Wallace, Henry A., 31, 34, 39, 46, 234
- Wallgren, Mon C., 336–37
- Walton, E. T. S., 5–6
- War Department Miscellaneous Group, 521
- War Manpower Commission, 351–54, 364–65, 370, 461
- War Production Board
  - electric power requirements, 380–83, 387–88, 393
  - priorities, 57, 353
  - procurement, 67, 80
- Warren, Col. Stafford L., 91*n*, 594
  - bombing survey team, 544, 549–50
  - health program, 411–15, 421, 425–26
- Washington Liaison Office, 81–82, 89, 91, 130, 178, 180*n*, 310, 349, 377, 380
- *Washington Post*, 279
- Watson, Maj. Gen. Edwin M., 19–20, 22–23
- Watson, William W., 247
- Watts Bar Dam, Tenn., 390
- Waymack, William W., 597
- Weapon development and testing. *See* Los Alamos Laboratory.
- Weaver, Brig. Gen. Theron D., 60, 81–82
- Webster, W. L., 248
- Wegener, A. L., 374
- Weil, George, 103–04
- Weisskopf, Victor, 12
- Welsh, Col. Arthur B., 412
- Wendover Field, Utah, 507, 521–22, 526–27, 581
- Wensel, H. T., 44
- Wesson, Maj. Gen. Charles M., 23
- Western Defense Command, 261, 263–64
- Western Union Company, 397
- Westinghouse Electric and Manufacturing Company, 62, 64, 124, 129–30, 153
- Westinghouse Research Laboratories, 51, 487
- West Stands. *See* Stagg Field, University of California.
- Wheeler, John A., 8*n*, 203, 589
- Whitaker, Martin D., 112, 114, 208, 210
- White, Wallace H., 273
- White Bluffs, Wash., 110, 211–12, 332, 392, 405, 450–51, 456
- Wickard, Claude, 329
- Wigner, Eugene
  - nuclear research, 8*n*, 11, 13, 21–22, 24
  - pile process, 190, 192, 195–97
- Wigner Effect, 592
- Williams, Roger, 101, 113–14, 199, 203, 221
- Williams, Maj. Walter J., 137
- Wilson, Carroll L., 597–98, 600
- Wilson, E. Bright, Jr., 197, 490
- Wilson, Robert R., 528
- Wilson, Col. Roscoe C., 520–21
- Winant, John G., 249–51, 297–98, 300
- Winkleman, D. W., Company, 160
- Winne, Harry A., 574
- Women's Army Auxiliary Corps, 358
- Women's Army Corps, 277, 357–58, 397, 473
- Woolworth Building, 151
- Work stoppages and absenteeism, 206, 370–71, 375–76
- Wright, Brig. Gen. Boykin C., 298
- Wuerttemberg, Germany, 287, 289

XAX development plant, 134–35, 142
Xenon, 221–22

Yakima, Wash., 110, 337–39, 402
Yakima County, Wash., 110
Yaku-shima, Japan, 540
Yale University, 308, 315
Yancey, E. B., 199
Yokkaichi, Japan, 528
Yontan Field, Okinawa, 541

Zinn, Walter, 8*n*
Zirconium oxide, 133

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